TECHNICAL MANUAL
888-2339-002

DX100-3F
994-9369-103

T.M. No. 888-2339-002

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Returns And Exchanges

Damaged or undamaged equipment should not be returned unless written approval and a Return Authorization is received from HARRIS CORPORATION, Broadcast Communications Division. Special shipping instructions and coding will be provided to assure proper handling. Complete details regarding circumstances and reasons for return are to be included in the request for return. Custom equipment or special order equipment, that is not defective, is not returnable. In those instances where return or exchange of equipment is at the request of the customer, or convenience of the customer, a restocking fee will be charged. All returns will be sent freight prepaid and properly insured by the customer. When communicating with HARRIS CORPORATION, Broadcast Systems Division, specify the HARRIS Order Number or Invoice Number.

Unpacking

Carefully unpack the equipment and preform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that all received equipment is not damaged. Locate and retain all PACKING CHECK LISTs. Use the PACKING CHECK LIST to help locate and identify any components or assemblies which are removed for shipping and must be reinstalled. Also remove any shipping supports, straps, and packing materials prior to initial turn on.

Technical Assistance

HARRIS Technical and Troubleshooting assistance is available from HARRIS Field Service during normal business hours (8:00 AM - 5:00 PM Central Time). Emergency service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, HARRIS CORPORATION, Broadcast Communications Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a FAX facility (217/221-7096).

Replaceable Parts Service

Replacement parts are available 24 hours a day, seven days a week from the HARRIS Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, HARRIS CORPORATION, Broadcast Communications Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. The HARRIS factory may also be contacted through a FAX facility (217/221-7096) or e-mail at TSUPPORT@HARRIS.COM.

NOTE

The # symbol used in the parts list means used with (e.g. #C001 = used with C001).

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don’t take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

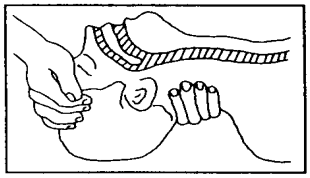
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

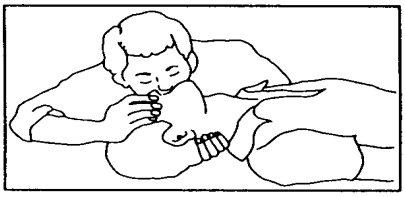
IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

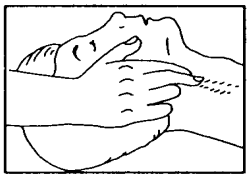
(B) BREATHING

IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING



TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL
4 QUICK FULL BREATHS
REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

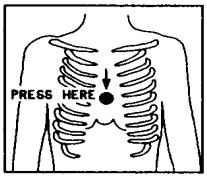
CHECK
CAROTID PULSE



IF PULSE ABSENT.
BEGIN ARTIFICIAL
CIRCULATION

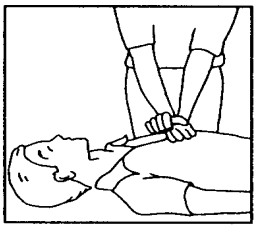
(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE
- ONE RESCUER
- 15 COMPRESSIONS
- 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE
- TWO RESCUERS
- 5 COMPRESSIONS
- 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

A. KEEP THEM WARM
B. KEEP THEM AS QUIET AS POSSIBLE
C. LOOSEN THEIR CLOTHING
D. A RECLINING POSITION IS RECOMMENDED

WARNING: Disconnect primary power prior to servicing.

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is a brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin
   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)
   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE:

ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

TABLE OF CONTENTS

Section I
Introduction/Specifications

Scope and Purpose 1-1
Equipment Description 1-2
Block Diagram 1-2
Available Options 1-2

Section II
Initial Turn-On

Initial Power On 2-1
Frequency Change 2-1
Low Power Tune 2-1
Medium Power Check 2-1
High Power Tune 2-2
Antenna VSWR Null 2-2
Recording Normal Meter Readings 2-2

Section III
Operators Guide

Introduction 3-1
Operating Procedures 3-1
Daily Preoperational Checkout 3-1
Transmitter Turn-On Procedure 3-1
Transmitter Turn-Off Procedure 3-2
Transmitter Operations 3-2

Section IIIA
Controls and Indicators

Section IV
Overall System Theory

Introduction 4-1
Block Diagram Description 4-1
Protection Of Personnel 4-7
Transmitter Protection 4-8
RF Circuits In The Transmitter 4-8
Transmitter AC Power Circuits 4-11
Drive Multimeter 4-16
Control Multimeter 4-18

Section V
Maintenance/Alignments

Introduction 5-1
Frequency Change Procedures 5-1
Maintenance 5-1
Preventive Maintenance 5-2

Section VI
Troubleshooting

Introduction 6-1
Making Safe Measurements 6-1
Troubleshooting Control Front Panel Indicators Faults . . . 6-1
Troubleshooting Faults In The RF Chain 6-2
Troubleshooting Frequency Control Panel Faults 6-13
Troubleshooting Faults on the Power Supply Status Panel 6-18
System Faults With No Indication On The Front Panel 6-19
Troubleshooting Low Voltage Supplies 6-20
Measuring RF Drive Level And Phase 6-22
Measuring RF Drain Waveform And Phase 6-22

Section VIA
Emergency Operating Procedures

Introduction 6-1
RF System Bypassing 6-1
Audio/Digital Modulation System Bypassing 6-2
Frequency Control Bypassing 6-3

SECTION VII
PARTS LIST

Section A
Synthesizer Interface

Introduction A-1
Function A-1
Oscilloscope Waveform Plots A-1
Location A-1
Block Diagram Description A-1
Detailed Circuit Description A-2
Troubleshooting A-6
Removal\Replacement A-7
Alignment A-7

Section B
RF Interface

Introduction B-1
Function B-1
Oscilloscope Waveform Plots B-1
Location B-1
Block Diagram Description B-1
Detailed Circuit Description B-2
RF Interface Troubleshooting B-3
Removal\Replacement B-4
Alignment B-4

Section C
Driver Combiner Motherboard (A5)

Introduction C-1
Function C-1
Location C-1
Detailed Circuit Description C-1
Troubleshooting C-2
Driver Combiner Motherboard Removal/Replacement . . . C-5
Buffer Amplifier (A4) C-7
Predriver, PD1 . . . . . C-12
Drivers, D1 through D14 . . . . . C-14

Section D
Predriver Tuning Board

Introduction D-1
Function D-1
Location D-1
Detailed Circuit Description D-1
Predriver Tuning Board Troubleshooting D-1
Removal\Replacement D-2
Alignment D-2

Section E
Driver Encoder (A7)

Introduction E-1
Function E-1
Oscilloscope Waveform Plots E-1

WARNING: Disconnect primary power prior to servicing.

Location E-1
Block Diagram Description E-1
Detailed Circuit Description E-2
Troubleshooting E-7
Removal and Replacement E-9
Alignments E-9

Section F
RF Combiner Motherboards (A10-A19)

Introduction F-1
Function F-1
Location F-1
Detailed Circuit Description - Main RF Combiner Motherboard F-1
Detailed Circuit Description - Binary RF Combiner Motherboard F-1
Troubleshooting F-2
RF Combiner Motherboard Removal F-2
RF Combiner Motherboard Replacement F-2

Section G
RF Amplifier Module

Introduction G-1
Function G-1
Location G-1
Block Diagram Description G-2
Detailed Circuit Description G-2
Maintenance G-5
Troubleshooting RF Amp Modules. G-6

Section H
Output Monitor/Output Sample

Introduction H-1
Function H-1
Oscilloscope Waveform Plots H-1
Location H-1
Block Diagram Description H-2
Detailed Circuit Description H-2
Troubleshooting the Output Monitor Board H-7
Removal and Replacement H-9
Alignment H-9
Output Sample Board. H-11
Introduction H-11
Location H-11
Function H-11
Detailed Circuit Description H-11
Troubleshooting H-11
Removal and Replacement H-11
Alignments H-11

Section J
Analog Input Board

Introduction J-1
Function J-1
Location J-1
Oscilloscope Waveform Plots J-1
Block Diagram Description J-1
Detailed Circuit Description J-2
Troubleshooting J-6
Removal and Replacement J-8
Alignments J-8

Section K
Analog To Digital Converter

Introduction K-1
Function. K-1
Location. K-1
Block Diagram Description K-1
Detailed Circuit Description. K-2
Troubleshooting K-4
Removal and Replacement. K-6
Alignments K-6

Section L
Modulation Encoders (A25-A29)

Introduction. L-1
Function. L-1
Location. L-1
Big Step Modulation Encoders L-1
Binary Modulation Encoder (A25) L-14

Section M
Controller (A31)

Introduction. M-1
Function. M-1
Location. M-1
Block Diagram Description M-1
Detailed Circuit Description. M-3
Troubleshooting M-23
Removal and Replacement. M-25
Alignments M-25
LED Board M-25
Switch Board/Meter Panel M-25

Section N
External Interface (A23)

Introduction. N-1
Function. N-1
Location. N-1
Detailed Circuit Description. N-1
Troubleshooting N-4
Removal and Replacement. N-5
Alignments N-5

Section P
Transmitter Interface

Introduction. P-1
Function. P-1
Location. P-1
Detailed Circuit Description. P-1
Troubleshooting Transmitter Interface. P-3
Removal and Replacement. P-4
Alignments P-4

Section Q
Frequency Control Board

Introduction. Q-1
Function. Q-1
Location. Q-1
Block Diagram Description Q-1
Detailed Circuit Description. Q-1
Troubleshooting Q-5
Removal\Replacement Q-6
Alignment Q-6

WARNING: Disconnect primary power prior to servicing.

Section R
Frequency Control Interface
Introduction R-1
Function R-1
Location R-1
Block Diagram Description R-1
Detailed Circuit Description R-2
Troubleshooting R-9
Removal\Replacement R-10
Alignment R-11

Section S
3F Select Board
Introduction S-1
Function S-1
Location S-1

Section T
3F Controller Board
Introduction T-1
Function T-1
SERVO CONTROL T-1
Location T-1

Section U
Servo Calibration
Servo Calibration U-1

Appendix A
DX Digital Modulation Technology and Concepts
DX Digital Modulation Technology and Concepts a-1

WARNING: Disconnect primary power prior to servicing.

1.1 Scope and Purpose

This technical manual contains the information necessary to install and maintain the DX100-3F. The various sections of this technical manual provide the following types of information.

- Section I, Introduction/Specifications, provides general manual layout, frontispiece, equipment description, block diagram, and available options.
- Section II, Installation/Initial Turn-On, provides initial turn on instructions.
- Section III, Operators Guide, provides normal turn-on/turn-off procedures, taking meter readings, and transmitter operations.
- Section III-A, Controls/Indicators, provides identification and functions of all external panel controls and indicators, plus multimeter reading log sheets.
- Section IV, Overall System Theory provides block diagram and detailed theory of operation of the transmitter and various sections that apply to the overall transmitter. It includes the following:
  - RF Section
  - Predriver Splitter (A46) and Driver Drive Cables
  - RF Splitter (A6) and RF Drive Cables
  - Output Network
  - Power Supply Section
  - Low Voltage Power Supply
  - RF Amplifier Power Supply
  - Driver Multimeter (A9)
  - Control Multimeter (A41)
- Section V, Maintenance/Alignments, provides a transmitter frequency change procedure.
- Section V-A, Cabinet Views, provides drawings that show the location of major components and modules in the cabinets.
- Section VI, Troubleshooting, provides simplified flow style troubleshooting procedures down to the board level.
- Section VI-A, Emergency Operating Procedures, provides methods to maintain on-air operation of the transmitter in the event of a failure.
- Section VII, Parts List, provides a parts list for the overall transmitter as well as individual modules.

The following subsections provide principles of operations for boards and modules in the DX100-3F:

- Section A, Synthesizer Interface (A1) [A2 optional]
- Section B, RF Interface (A3)
- Section C, Driver Combiner Motherboard (A5)
  - Buffer Amplifier (A4)
  - Predriver (PD1)
  - Drivers (D1-D14)
- Section D, Predriver Tuning Board (A54)
- Section E, Driver Encoder (A7)
- Section F, RF Combiner Motherboards
  - Main Combiner Motherboards (A11-A19)
  - Binary Combiner Motherboard (A10)

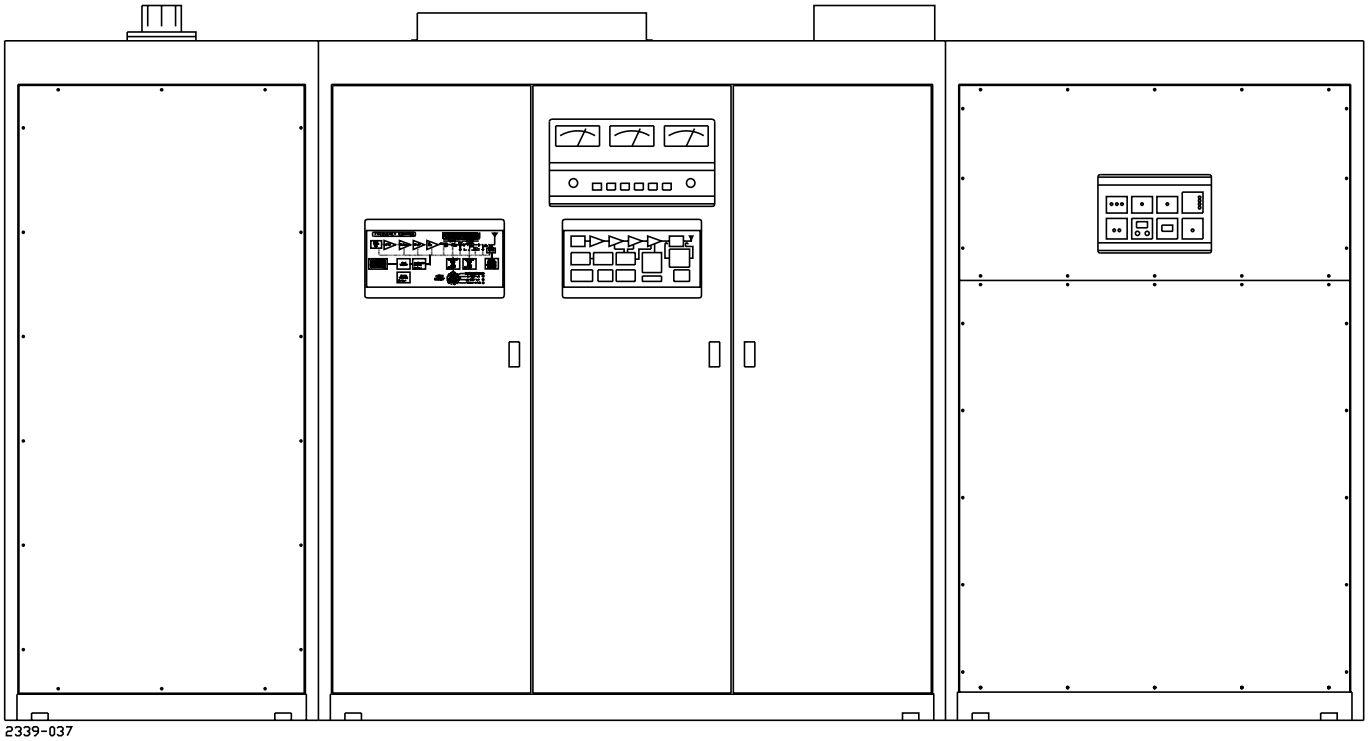


Figure 1-1. Front View of Transmitter

WARNING: Disconnect primary power prior to servicing.

- Section G, RF Amplifiers
- Section H, Output Monitor (A21)
  - Output Sample (2A1)
  - VSWR Compensation (A56)
- Section J, Analog Input Board (A22)
- Section K, Analog To Digital Converter (A32)
- Section L, Modulation Encoders
  - Big Step Modulation Encoders (A26-A29)
  - Binary Modulation Encoder (A25)
  - Air Flow Monitors (A3, A24, A47-A49)
- Section M, Controller (A31)
  - LED Board (A42)
  - Switch Board/Meter Panel (A35)
- Section N, External Interface (A23)
- Section P, Transmitter Interface (A30)
- Section Q, Frequency Control Board (A51)
- Section R, Frequency Control Interface (A50)
- Appendix A, Digital Terms and Concepts

1.2 Equipment Description

The DX100-3F is a 3 frequency agile solid state medium wave amplitude modulation transmitter with a rated power output level of 100 kilowatts. The transmitter is capable of 110 kilowatts and has three power level selections that are user set. The frequency selections are 585 kHz, 684 kHz and 936 kHz.

1.3 Block Diagram

A Block Diagram description is contained in Section IV, Overall System Theory.

1.4 Available Options

480VAC to 240VAC Stepdown Transformer

A2 Synthesizer Interface B

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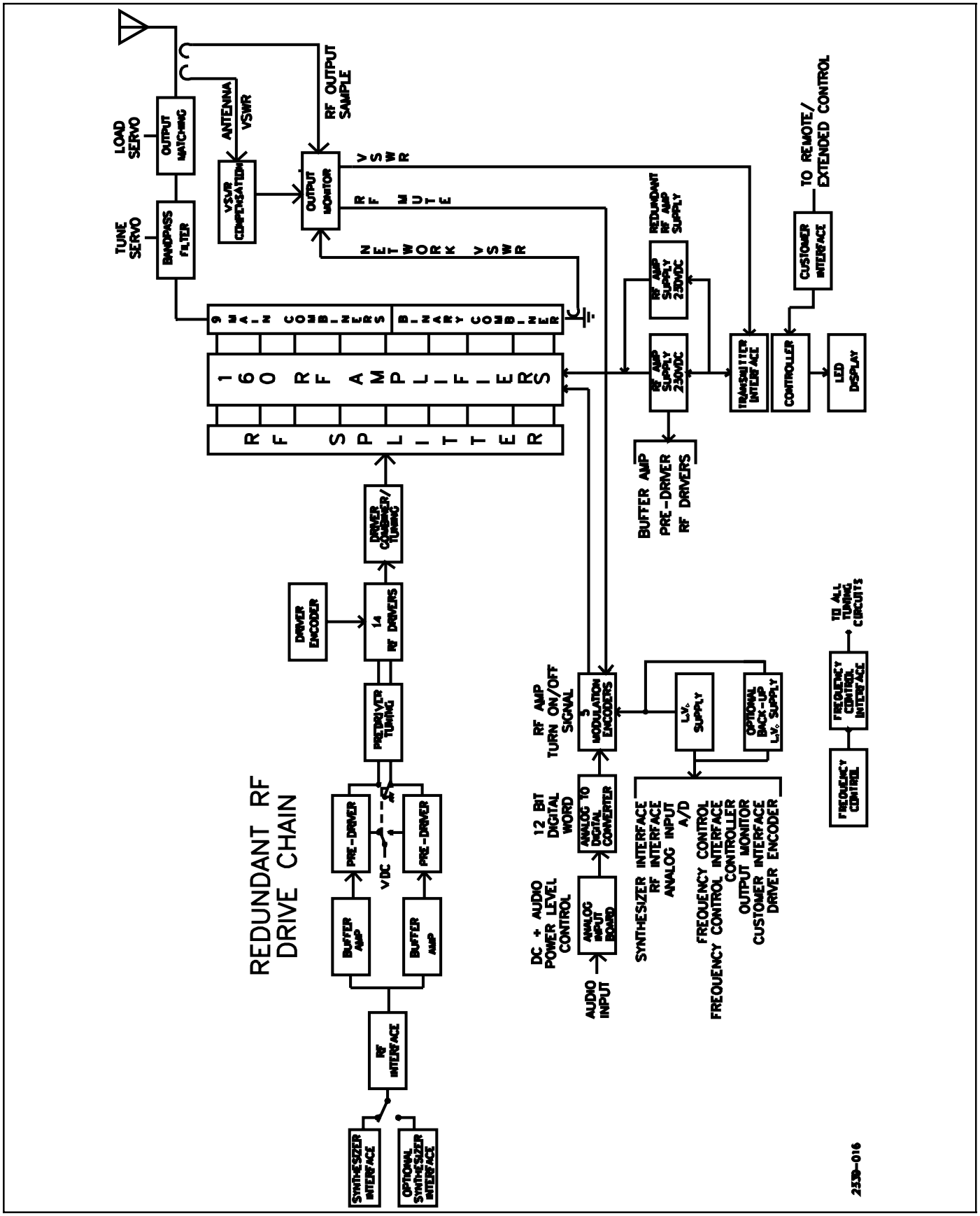


Figure 1-2. DX100-3F Block Diagram

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

The following procedure assumes that the transmitter has already been correctly installed and is ready for turn-on.

Note

If AC power is loss for an extended period of time and the Battery Backup Voltage falls too low to store the Frequency references, you will need follow the procedure under "Initial Power On". If AC loss for an extended period of time happens often you may want to provide an external battery backup via TB1 1-2 on the Transmitter Interface. Refer to P.4.3.1.2 "External Battery Input".

2.1 Initial Power On

a. Select the Servo Breaker to the OFF position.
b. Enable the Low Voltage and Main Breaker.
c. Wait for 60 seconds then ENABLE the SERVO Breaker.
d. Select S100 to the NORM position.
e. Select a different frequency other than the one that is already selected. This is to insure the relays and servos are in the proper location.
f. Depress the Reset button on the Control front.
g. On the Controller move S1 from NORM to MUTE position.
h. On the Analog Input board, rotate R65, R66, and R67 fully counter clockwise and set S1 to the CALIBRATE position.

2.2 Frequency Change

a. Select one of the three available frequencies for operation that is listed on the Factory Test Data Sheets.
b. Verify the TUNE meter indicates the same as the new 2L2 number per Transmitter Band Chart.
c. Verify the LOAD meter indicates the same as the new 2C1 number per transmitter Band Chart.
d. Set S100 to the CALIBRATE position.

2.3 Low Power Tune

a. Press the LOW power switch on the front panel. The Power meter selector switch should be in FWD.
b. On the Controller move S1 from MUTE to NORM and begin raising the RF forward power by slowly turning R66 clock- wise.
c. Stop increasing power when Forward power is 10 kilowatts.
d. Using the front panel meters, verify the following conditions:
   1. PA +VDC = 240 to 250 volts.
   2. PA Current = 60 to 80 amps.
   3. Number of RF Amplifiers (steps) ON should be 21 to 23 (Open the left front door and count the number of illuminated green LED's on the RF Amplifiers along the left side of the compartment starting at the bottom and counting upward).
e. The TUNE SERVO Raise/Lower may now be adjusted for a peak in power output.
f. The LOAD SERVO Raise/Lower is adjusted in conjunction with the power control potentiometer to properly adjust the Number of steps that are turned on for 10 kW.
   1. Use the number of steps turned on from the Factory Test Data to help determine if the LOADING needs adjusting; e.g. if the desired number of steps is 22 and you have more than 22 on, adjust the Low power control R66 on the Analog Input board counter clockwise until 22 steps are turned on. Then adjust the LOAD Servo Raise/Lower until 10 kW is reached.
      If you have less than 22 steps on, adjust the Low power control R66 on the Analog Input Board clock-wise until 22 steps are turned on. Then adjust the LOAD Servo Raise/Lower until 10 kW is reached.
g. Repeat the TUNE and LOAD SERVO adjustments as they interact with each other.

If an Antenna VSWR overload occurs before 10 kW is reached, skip to the Antenna Null adjustment following this section and return here when completed.

h. Do an RF Amp temperature test by moving your hand about 1 inch (2.54 cm) in front of the RF Amp doors to feel the air temperature. It should only be slightly warm. The left PA compartment temperature will be slightly warmer than the other compartments. This is normal since these are the RF Amps being turned on.
i. Check the 10 kW meter readings with the readings on the Factory Test Data Sheets under PA Voltage, PA Current, and Number Of Steps On. If all are within 10%, continue with the next step.

2.4 Medium Power Check

a. Depress the MEDIUM power switch on the front panel.
b. Slowly adjust R67 CW until the indicated output on the power meter shows 50 kW.
c. Check the 50 kW meter readings with the readings on the Factory Test Data Sheets under PA Voltage, PA Current, and Number Of Steps On. If all are within 10%, continue with the next step.
d. If the readings are not within 10%, retune the output network according to the Low Power Tune described above.

WARNING: Disconnect primary power prior to servicing.

If an Antenna VSWR overload occurs before 50 kW is reached, skip to the Antenna Null adjustment following this section and return here when completed.

2.5 High Power Tune

a. Depress the High Power switch on the front panel.

b. Adjust R65 clockwise until 100 kW is reached.

c. Using the front panel meters, verify the following conditions:

1. PA +VDC = 225 to 235 volts.
2. PA Current = 460 to 470 amps.
3. Number of RF Amps ON = 64 to 66 (Open the left front door and count the number of illuminated green LED's on the RF Amplifiers along the left side of the compartment starting at the bottom and counting upward).

d. The TUNE SERVO Raise/Lower may now be adjusted for a peak in power output.

Note

Reference 3F Controller potentiometer settings.

e. The LOAD SERVO Raise/Lower is adjusted in conjunction with the power control potentiometer to properly adjust the Number of steps that are turned on for 100 kW.

1. Use the number of steps turned on from the Factory Test Data to help determine if the LOADING needs adjusting; e.g. if the desired number of steps is 65 and you have more than 65 on, adjust the High power control R65 on the Analog Input board counter clockwise until 65 steps are turned on. Then adjust the LOAD Servo Raise/Lower until 100 kW is reached.

   If you have less than 65 steps on, adjust the High power control R65 on the Analog Input Board clock-wise until 65 steps are turned on. Then adjust the LOAD Servo Raise/Lower until 100 kW is reached.

f. Repeat the TUNE and LOAD SERVO adjustments as they interact with each other.

NOTE

It is preferred to leave the tuning slightly on the inductive side of resonance for optimum efficiency and performance.

The inductive side of resonance is achieved by turning 2C1A counter clockwise from the point where the power peak is found. The capacitive side of resonance is normally indicated by a drop in current but does not drop as fast as the power when 2C1A is tuned off the peak. The transmitter should not be operated more that 8kW off of the power peak.

g. Do an RF Amp temperature test by moving your hand about 1 inch in front of the RF Amp doors to feel the air temperature flowing over the RF AMPS.

h. Return S1 on the Analog Input board to the NORMAL Position.

i. Refer to Section U for Servo Calibration.

j. Return S100 to the NORM Position.

2.6 Antenna VSWR Null

If an Antenna VSWR overload occurs before 100 kW is reached, note the Antenna Null position on the front panel multimeter. Increase or decrease the number in 1 step increments until the meter indication is nulled.

Additionally, "Fine Tuning" of the VSWR Null may be accomplished by using the Phase and Amplitude adjustments of the Output Monitor Board.

2.7 Recording Normal Meter Readings

Check all meter readings against the Factory Test Data sheets. It is strongly recommend that a permanent record of ALL meter readings be made on a recurring basis, i.e. weekly or monthly. A sample form for meter readings is contained in the operators guide section of this Manual.

WARNING: Disconnect primary power prior to servicing.

3.1 Introduction

This section contains information on day-to-day operation for the non-technical operator.

3.2 Operating Procedures

These procedures describe normal daily operation of the DX100-3F, including:

a. Daily pre-operational checkout
b. Transmitter turn-on procedures.
c. Transmitter turn-off procedures.
d. Transmitter operations.

It is important that the operator be aware of normal transmitter operation and performance, and note any changes or fault indications. Changes in operation may indicate a need for maintenance or corrective action before more serious problems develop.

NOTE

The following procedure assumes that the transmitter has been previously tuned to the correct frequency and is operating properly. For Frequency Change instructions, refer to the Maintenance Section of this manual.

WARNING

ALL SERVICE SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL. DANGEROUS VOLTAGES OR CURRENTS MAY BE PRESENT INSIDE WHEN DOORS ARE OPEN.

Normal operation and monitoring of the transmitter is accomplished through front panel controls, meters, and indicators. Read Section IIIA: Controls and Indicators.

NOTE

If remote/extended control of the transmitter is used, the station chief engineer or qualified technical staff member should provide instructions for operator use.

3.3 Daily Preoperational Checkout

The following paragraphs describe checks to be made before normal daily turn-on.

a. Check the transmitter maintenance log to make sure that maintenance performed on the transmitter, or other abnormal conditions, do not place any restrictions on transmitter operation. An example is a requirement to operate at reduced power.
b. Ensure that the transmitter RF output is properly terminated into the antenna. This may include determining that antenna pattern switching is correct.
c. Observe the Power Supply Status Panel located near the top of the right most cabinet. The indicators under 3PH A/C MAINS PROTECTION PH1, PH2, PH3 and under SINGLE PHASE A/C MAINS PROTECTION PH1, PH2 should all be illuminated GREEN. If an indicator is not GREEN, it is possible that the transmitter will operate, but contact maintenance personnel immediately.
d. Observe the Frequency Control front panel, there should be no RED indicators illuminated.
e. Check the Control front panel on the center front of the transmitter. If the transmitter is ready for operation, all the status, interlock, and overload LEDs will be green. If any LEDs are red, note which indicators are red so that information may be entered into the station maintenance log, then press the RESET button. All indicators should change to green when the RESET button is pushed and released. If any indicators are still red after operating the RESET, do not attempt to turn on the transmitter and contact maintenance personnel.
f. If no LEDs are lit, place the Low Voltage Enable switch to the STANDBY MODE and continue with the following steps.

3.4 Transmitter Turn-On Procedure

When the Preoperational Checkout has been completed and no problems are present, the transmitter is ready to turn on.

a. Set the selector switch below the POWER meter on the meter panel to FORWARD, if it is not already in that position.
b. Depress the LOW, the MEDIUM, or the HIGH pushbutton on the meter panel, depending on power level desired. Each of these pushbuttons will turn the transmitter on at the power level which has been preset.
c. The pushbutton you have operated should illuminate green, and power will come up to the preset level. (You should also hear three ‘clicks’ as contactors operate, then the blowers should start, then power will come up).

NOTE

During the Step Start sequence, you should see the following: RF Mute LED turns red for an instant, the VSWR test LED turns red for 4 seconds, and the Power meter will go to 1/4 of the power selected and then advance to the desired power level. This should take between .5 and 3 seconds.

d. Should FORWARD POWER not be correct, verify that you have selected the correct power level (LOW, MEDIUM, or HIGH). If not, depress the proper power level button, and check forward power again.
e. When the correct power level has been selected, but an adjustment in power is still needed, press the RAISE button to INCREASE power, or the LOWER button to DECREASE power. When you hold the button depressed and watch the FORWARD POWER indication, the power will change slowly. Hold the button until the power is correct.

WARNING: Disconnect primary power prior to servicing.

NOTE

RAISE and LOWER buttons will only change power level if the transmitter is operating in the HIGH, MEDIUM, or LOW function. This new power level will become the preset power until it is changed again. The Raise and Lower pushbuttons will adjust power +/-10% of the selected power level.

f. Check transmitter panel meter readings for normal values. If an abnormal meter reading is obtained, maintenance personnel should be contacted.

3.5 Transmitter Turn-Off Procedure

a. To turn off (de-energize) the transmitter, depress the OFF pushbutton.

b. The HIGH, MEDIUM, or LOW lamp will go out, you should hear the contactor as it de-energizes, and the blowers will stop.

c. With the POWER switch in the FORWARD position, the Power meter should indicate zero power. Supply voltage and supply current meters should both indicate zero readings.

3.6 Transmitter Operations

The following is intended to make the operator aware of some basic operational characteristics of the transmitter.

3.6.1 Routine Meter Readings

A sample logsheet is provided on in Section IIIA, Controls and Indicators. Copies can be made of the logsheet for station records. We suggest these readings be taken monthly at a minimum, however more frequent logs can be an important tool in assisting maintenance personnel.

3.6.2 Fault Conditions

The following describes normal transmitter actions for certain possible fault conditions. It is very important that operators log all abnormal operation, such as incorrect meter readings, overloads, fault indications, and transmitter shut-downs. A log or record of abnormal operating conditions will be useful to maintenance personnel in locating and correcting transmitter or other system problems.

3.6.2.1 Transmitter Shuts Off

The operator should first check for overload or fault indications that are RED and log any fault indications that are found. Press the RESET button on the Control front panel to clear fault indications. Control front panel indicators should change from RED to GREEN.

If any LEDs are still RED, contact maintenance personnel.

When the fault indicators are GREEN, follow the normal turn-on procedure.

If the transmitter shuts off again, and the same overload or fault indication comes on, try turning the transmitter on by using the LOW power button. Under some overload/fault conditions, a transmitter may operate satisfactorily at reduced power. If it will not come on at LOW power, contact maintenance personal.

3.6.2.2 AC Power Failure

If Battery Backup has been installed into the transmitter, no operator action is required for ac power failures of less than approximately 96 hours. The transmitter will automatically return to an on-air condition, at the same power level as before the power failure.

If Battery Backup has not been installed and ac power is off for more than about 10 minutes and power is restored you should have the following indications: the 3PH AC MAINS indicators PH1, PH2, PH3 and SINGLE PHASE AC MAINS indicators PH1 and PH2 on the Power Supply Status Panel have returned to GREEN. The transmitter will have to be manually turned on and retuned to the operating frequency before operation can resume. Contact maintenance personnel immediately.

3.6.2.3 RF Amp Power Supply Current Fault

During a Current Fault condition the transmitter will shut off and the indicator will change to RED. The transmitter will attempt to restart by itself when the fault is no longer present.

a. If the transmitter turns back on and stays on, check program modulation level. If overmodulating on positive peaks, reduce audio level to reduce modulation level.

b. If the transmitter shuts off again and no longer automatically restarts. Log or record the fault, RESET the fault indicator, and try turning the transmitter on.

c. If the fault occurs again, try operating at LOW power. If the transmitter will operate at LOW power, operation may continue on a temporary, emergency basis.

3.6.2.4 Power Reduction

The transmitter will reduce the power output in steps during certain faults. When the fault is no longer present, the transmitter will increase the power output in steps back to the original level. This is done automatically by the transmitter and no operator intervention is required.

If the fault was only a temporary condition, the recovery process can be advanced by depressing the FAULT RESET pushbutton. If the indicator will not reset or the power level of the transmitter has been lowered drastically, contact maintenance personnel immediately.

If the power output has been reduced and the Analog Input Power Foldback indicator is RED, the transmitter has responded to one of the following faults.

3.6.2.5 VSWR Faults

If the OUTPUT MONITOR NETWORK VSWR, ANTENNA VSWR, OR VSWR TEST indicators are RED or are flashing RED, the following may be the cause:

a. This may be a normal occurrence during a thunderstorm, rain storm, blowing sand, or under conditions of ice on the antenna and will stop when the weather conditions improve.

WARNING: Disconnect primary power prior to servicing.

b. The indicators may flash RED when overmodulation occurs. Reducing modulation to normal levels may correct the condition.

c. If the indicators remain RED and weather conditions or overmodulation are not the cause, transmitter and/or antenna problems are indicated.

3.6.2.6 Temperature Faults

If the RF AMP TEMP or RF AMP POWER SUPPLY TEMP FAULT indicator is RED, the following may be the cause:

a. Failure of the building cooling system (high ambient temperatures).

b. Possible transmitter mistuning.

3.6.2.7 Air Flow Faults

If the AIR FLOW REDUCED indicator is RED, the following may be the cause:

a. Obstruction of air flow at the air intake on the transmitter rear doors or at the air outlet on the transmitter top.

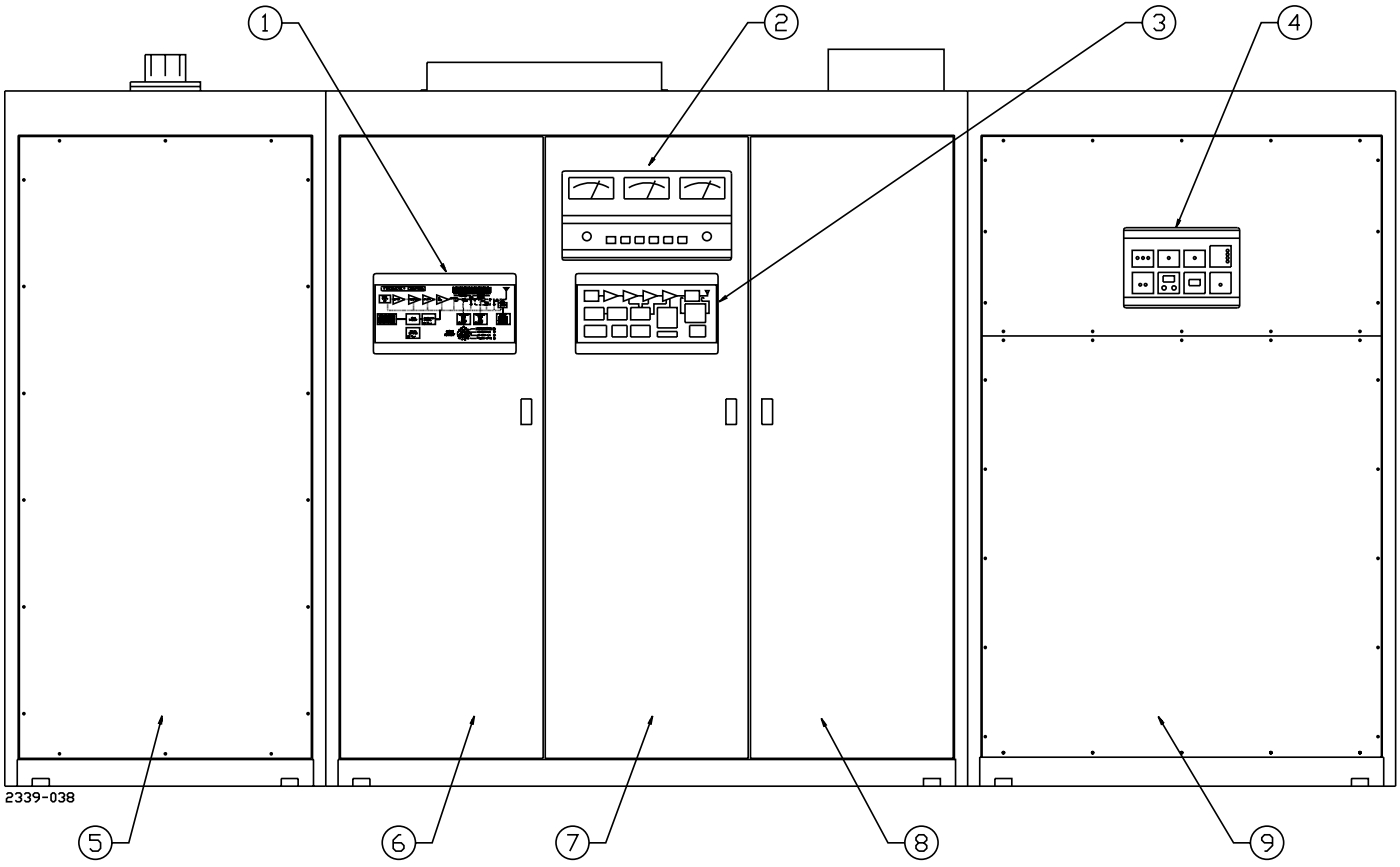
b. Dirty or clogged air filters.

3.6.2.8 RF Amp Fuse

The transmitter will continue to operate safely, although power output will be slightly reduced. The fault indication can not be RESET. The fault must be corrected to clear the fault indication. Continue normal operation and contact maintenance personnel.

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.



REF.	CONTROL/INDICATOR	FUNCTION
1	Frequency Control Panel	See Table 3-1 and Figure 3-1.
2	Switch Board/Meter Panel	See Table 3-2 and Figure 3-2.
3	Control Front Panel	See Table 3-3 and Figure 3-3.
4	Power Supply Status Panel	See Table 3-4 and Figure 3-4.
5	Output Network Cabinet	
6	Left PA Cabinet	
7	Center PA Cabinet	
8	Right PA Cabinet	
9	Power Supply Cabinet	

WARNING: Disconnect primary power prior to servicing.

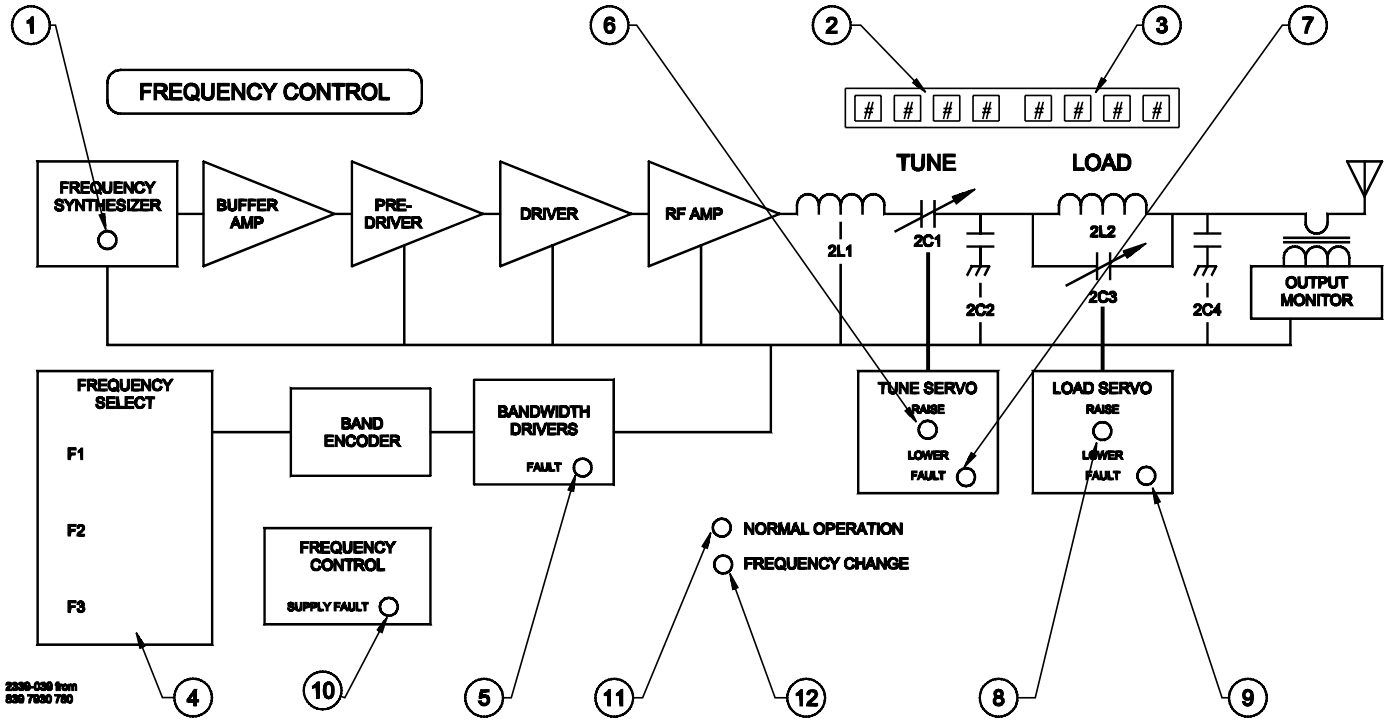


Figure 3-1
Frequency Control Panel Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

Table 3-1. Frequency Control Panel
Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	FREQUENCY SYNTHESIZER LED	GREEN indicates desired frequency is acceptable. RED indicates desired frequency is out of range.
2	TUNE POSITION METER/FREQUENCY CONTROL BOARD MULTIMETER	NOTE - The following assumes S2 on the Frequency Control board is in the NORMAL position. When in the FREQUENCY CHANGE Mode, the meter indicates the proper position for the TUNE SERVO. When in the LOW POWER TUNE or HIGH POWER TUNE Mode, the meter indicates the actual position of the TUNE SERVO. When in the NORMAL OPERATION Mode, the meter is turned off. NOTE - If S3 on the Frequency Control board is depressed in any mode, the meter will indicate the proper position for the TUNE SERVO. NOTE - If S2 on the Frequency Control board is in the METER position, the TUNE meter becomes a Multimeter for the Frequency Control board - refer to Figure 3-7 and Table 3-7 for more information.
3	LOAD POSITION METER	When in the FREQUENCY CHANGE Mode, the meter indicates the proper position for the LOAD SERVO. When in the LOW POWER TUNE or HIGH POWER TUNE Mode, the meter indicates the actual position of the LOAD SERVO. When in the NORMAL OPERATION Mode, the meter is turned off.
4	FREQUENCY SELECT SWITCHES	Used to select the operating frequency in kHz of 585, 684 or 936kHz.
5	BANDSWITCH DRIVERS FAULT LED	GREEN indicates normal operation. RED indicates a cable is disconnected, 2L1 switch not in the proper position, or loss of +24Vdc relay supply.
6	TUNE SERVO SWITCH	In the normal (center) position, the tuning servo motor is not active. In the RAISE (upper) position, the tuning servo motor is rotating clockwise (as viewed from the rear of the transmitter) and the capacitance is decreased. In the LOWER (down) position, the tuning servo motor is rotating counter-clockwise (as viewed from the rear of the transmitter) and the capacitance is increased.
7	TUNE SERVO FAULT LED	GREEN indicates the tuning servo motor is in the proper position. RED indicates the tuning servo motor is not in the proper position.
8	LOAD SERVO SWITCH	In the normal (center) position, the loading servo motor is not active. In the RAISE (upper) position, the loading servo motor is rotating clockwise (as viewed from the rear of the transmitter) and the inductance is decreased. In the LOWER (down) position, the loading servo motor is rotating counter-clockwise (as viewed from the rear of the transmitter) and the inductance is increased.
9	LOAD SERVO FAULT LED	GREEN indicates the loading servo motor is in the proper position. RED indicates the loading servo motor is not in the proper position.
10	FREQUENCY CONTROL SUPPLY FAULT LED	GREEN indicates normal operation. RED indicates failure of a power supply on the Frequency Control board.
11	NORMAL OPERATION LED	Illuminated GREEN only when in this mode.
12	FREQUENCY CHANGE LED	Illuminated YELLOW only when in this mode.

WARNING: Disconnect primary power prior to servicing.

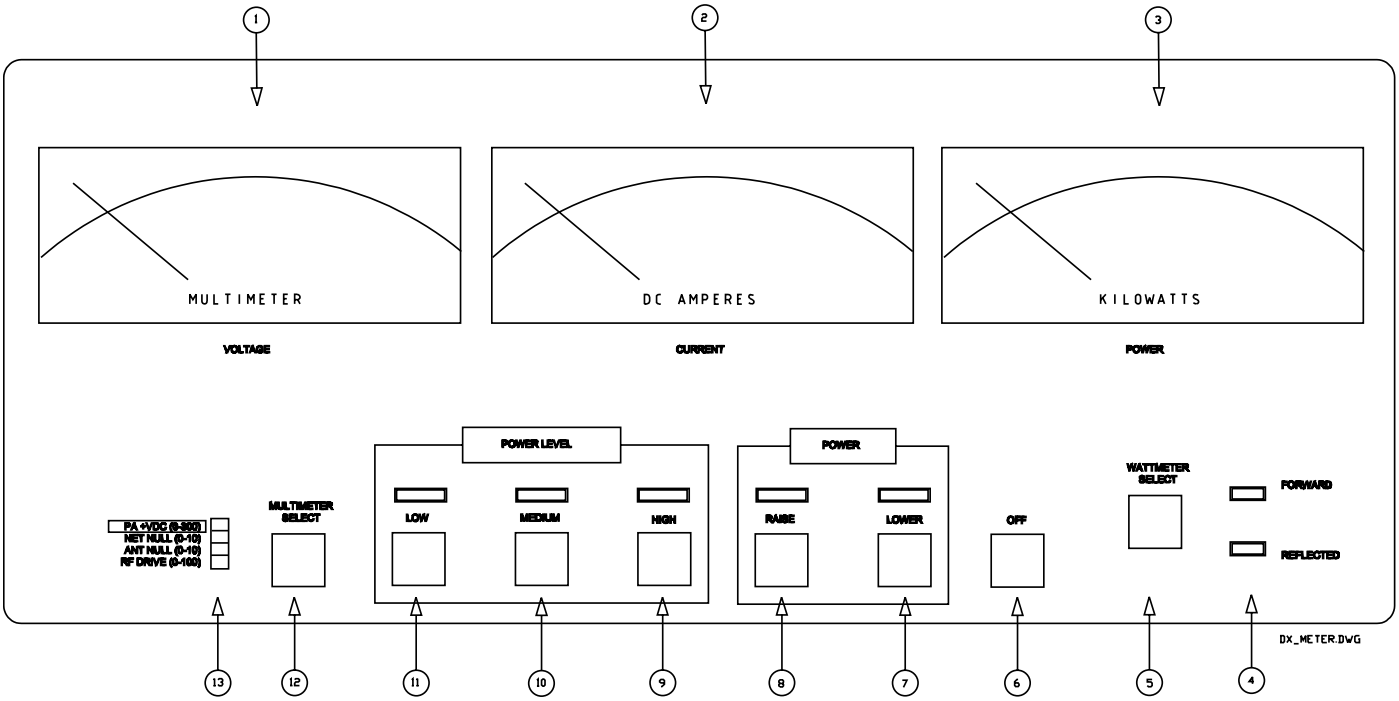


Figure 3-2. Switch Board/Meter Panel Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

Table 3-2
Switchboard/Meter Panel Controls and Indicators

REF.	CONTROL/INDICATOR	FUNCTION
1	VOLTAGE multimeter	Indicates voltages at points selected by the Multimeter Switch (Ref. 11).
2	SUPPLY CURRENT meter	Indicates the 230V supply current being supplied to the Power Amplifier.
3	POWER meter	Indicates either FORWARD or REFLECTED power at the transmitter output, whichever is selected by the POWER METER selector switch (Ref. 4).
4	POWER, selector	Selects Forward power output or Reflected power, to be read on the POWER meter.
5	OFF, pushbutton	Used to turn the transmitter off.
6	LOWER, pushbutton	Used to adjust power level. When the transmitter is in the LOW, MEDIUM, or HIGH power mode, depress to LOWER power output and hold until desired power is reached. INDICATOR illuminates while power is being lowered.
7	RAISE, pushbutton	Used to adjust power level. When the transmitter is in the LOW, MEDIUM, or HIGH power mode, depress to RAISE power output and hold until desired power is reached. INDICATOR illuminates while power is being raised.
8	HIGH, pushbutton	Used to turn the transmitter on at the preset HIGH power level, or to change power to the preset HIGH power level. The pushbutton will illuminate when in the HIGH power mode.
9	MEDIUM, pushbutton	Used to turn the transmitter on at the preset MEDIUM power level, or to change power to the preset MEDIUM power level. The pushbutton will illuminate when in the MEDIUM power mode.
10	LOW, pushbutton	Used to turn the transmitter on at the preset LOW power level, or to change power to the preset LOW power level. The pushbutton will illuminate when in the LOW power mode.
11	MULTIMETER switch	Selects the desired function to be monitored by the VOLTAGE multimeter.

WARNING: Disconnect primary power prior to servicing.

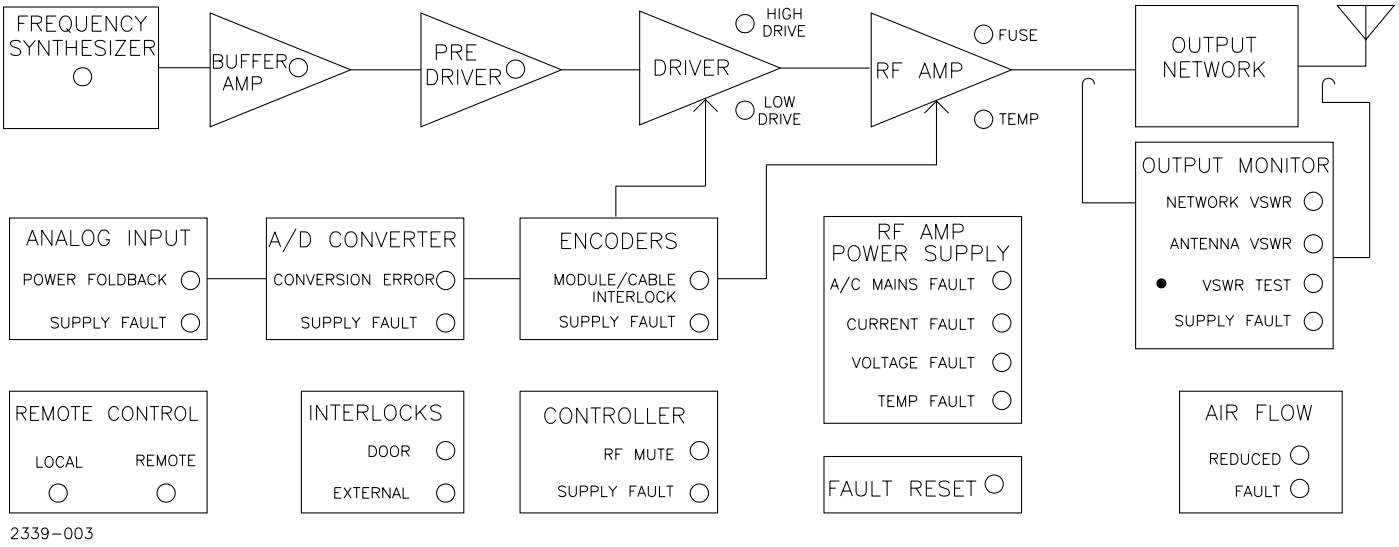


Figure 3-3
Control Front Panel Controls and Indicators

Table 3-3
Control Front Panel Controls and Indicators

CONTROL/INDICATOR	FUNCTION
FREQUENCY SYNTHESIZER	Indicates Frequency Synthesizer board rf output status. GREEN indicates normal rf output; RED indicates low or no rf output.
BUFFER AMP	Indicates buffer amplifier rf output status. GREEN indicates normal rf output; RED indicates low or no rf output.
PREDRIVER	Indicates predriver rf output status. GREEN indicates normal rf output; RED indicates low or no rf output.
DRIVER	
HIGH DRIVE	GREEN indicates normal drive level. RED indicates excessive rf drive level to the RF Amplifiers.
LOW DRIVE	GREEN indicates normal drive level. RED indicates low rf drive level to the RF Amplifiers.
RF AMP	
FUSE	GREEN indicates a normal, no fault condition. RED indicates a failure of an RF Amplifier fuse.
TEMP	GREEN indicates normal temperature of RF1. RED indicates excessive temperature of RF1.
OUTPUT MONITOR	
NETWORK VSWR	GREEN indicates that there is no detected VSWR in the network filter; RED indicates detected VSWR.
ANTENNA VSWR	GREEN indicates there is no detected VSWR in the antenna. RED indicates detected VSWR.
VSWR TEST, pushbutton	Used to test operation of VSWR logic, result of test is displayed on VSWR TEST indicator. When the pushbutton is depressed, the VSWR TEST indicator will turn RED for 4 seconds. If it returns to GREEN, a successful VSWR TEST has been performed. If it remains RED, a VSWR TEST has failed.
VSWR TEST indicator	Indicates result of VSWR TEST. GREEN indicates VSWR protection logic is functioning normally. RED indicates VSWR logic fault.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.

WARNING: Disconnect primary power prior to servicing.

Table 3-3
Control Front Panel Controls and Indicators
(Continued)

CONTROL/INDICATOR	FUNCTION
ANALOG INPUT	
POWER FOLDBACK	GREEN indicates normal operation. RED indicates transmitter has responded to a fault by reducing current power level.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply failure.
A/D CONVERTER	
CONVERSION ERROR	GREEN indicates normal operation of A/D converter. RED indicates conversion error in A/D converter.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates power supply failure.
ENCODERS	
MODULE/CABLE INTERLOCK	GREEN indicates all cables and modules are properly installed; RED indicates that a cable or module is not installed or connected.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply fault.
RF AMP POWER SUPPLY	
A/C MAINS FAULT	GREEN indicates normal operation. RED indicates a fault in the RF Amp Power Supply.
CURRENT FAULT	GREEN indicates normal status. RED indicates either average or peak RF Amp Power Supply overcurrent.
VOLTAGE FAULT	GREEN indicates normal status. RED indicates RF Amp Power Supply voltage is not within limits.
TEMP FAULT	GREEN indicates normal operation. RED indicates an overtemperature of RF AMP Power Supply.
REMOTE CONTROL	
LOCAL/REMOTE switch	Selects LOCAL or REMOTE control of the transmitter.
LOCAL, indicator	RED LED indicates that the remote control inputs to the transmitter are disabled, and only local control is possible.
REMOTE, indicator	GREEN LED indicates that the transmitter remote control inputs are active. (The transmitter may still be controlled with the panel pushbuttons as well.)
INTERLOCKS	
DOOR INTERLOCKS	GREEN indicates all doors are closed. RED indicates that a door is open, or not fully closed.
EXTERNAL INTERLOCKS	GREEN indicates a completed circuit. RED indicates an open circuit.
CONTROLLER	
RF MUTE	GREEN indicates normal operation. RED indicates controller responsed to a fault by reducing power to 0.
SUPPLY FAULT	GREEN indicates normal operation. RED indicates a power supply fault.
FAULT RESET pushbutton	Resets the overload indicators; when depressed, overload indicators will change from RED to GREEN if the cause of the overload has been cleared.
AIR FLOW	
REDUCED	GREEN indicates normal air flow. RED indicates less than normal air flow.
FAULT	GREEN indicates normal air flow. RED indicates severe loss of air flow.

WARNING: Disconnect primary power prior to servicing.

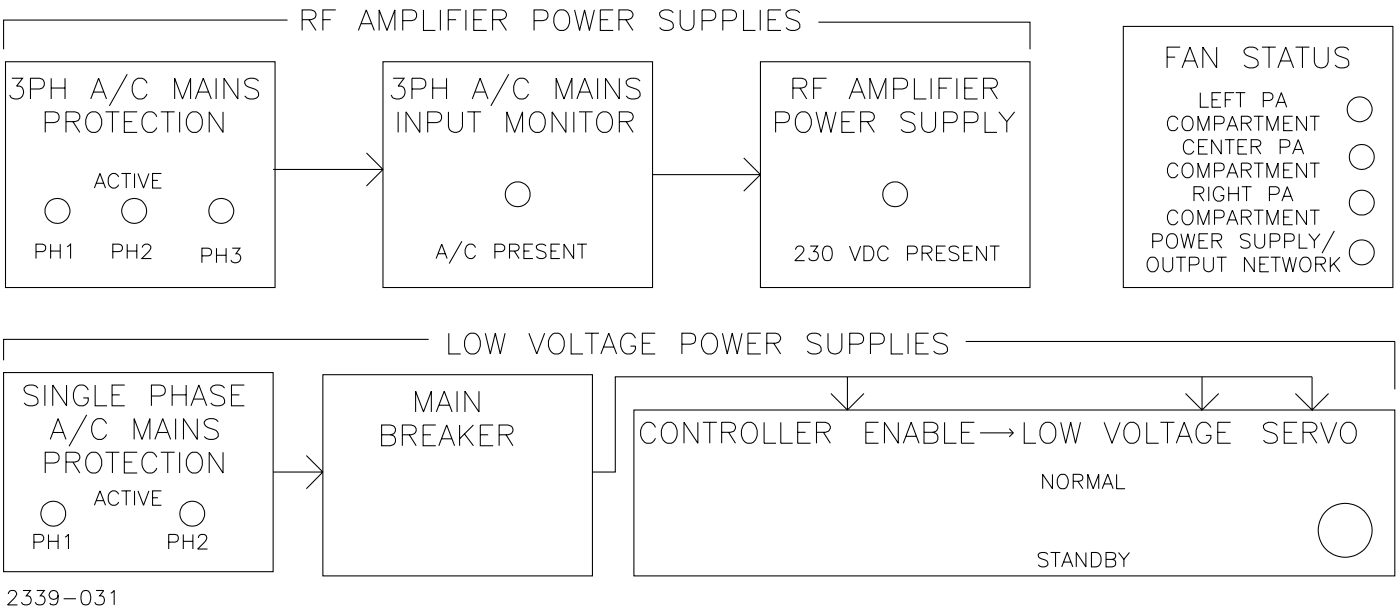


Figure 3-4
Power Supply Status Panel Cotrols and Indicators

Table 3-4
Power Supply Status Panel Cotrols and Indicators

CONTROL/INDICATOR	FUNCTION
RF AMPLIFIER POWER SUPPLIES	
3PH A/C MAINS PROTECTION ACTIVE	
PH1	GREEN indicates protection active. No illumination indicates failed protection or loss of phase at input.
PH2	GREEN indicates protection active. No illumination indicates failed protection or loss of phase at input.
PH3	GREEN indicates protection active. No illumination indicates failed protection or loss of phase at input.
3PH A/C MAINS INPUT MONITOR	
A/C PRESENT	GREEN indicates proper A/C input. No illumination indicates loss of A/C input.
RF AMPLIFIER POWER SUPPLY	
230VDC PRESENT	GREEN indicates supply voltage. No illumination indicates no supply voltage or transmitter is off.
FAN STATUS	
LEFT PA COMPARTMENT	GREEN indicates all fans operational. No illumination indicates a failed fan(s) or transmitter is off.
CENTER PA COMPARTMENT	GREEN indicates all fans operational. No illumination indicates a failed fan(s) or transmitter is off.
RIGHT PA COMPARTMENT	GREEN indicates all fans operational. No illumination indicates a failed fan(s) or transmitter is off.
POWER SUPPLY/OUTPUT NETWORK	GREEN indicates all fans operational. No illumination indicates a failed fan(s) or transmitter is off.
LOW VOLTAGE POWER SUPPLIES	
SINGLE PHASE A/C MAINS PROTECTION ACTIVE	
PH1	GREEN indicates protection active. No illumination indicates failed protection or loss of phase at input.

WARNING: Disconnect primary power prior to servicing.

Table 3-4
(Continued)

CONTROL/INDICATOR	FUNCTION
PH2	GREEN indicates protection active. No illumination indicates failed protection or loss of phase at input.
MAIN BREAKER	
UP	Single Phase A/C Mains applied to Controller and Low Voltage Power Supply Breakers & Enable Switch
DOWN	Single Phase A/C Mains disconnected from Controller and Low Voltage Power Supply Breakers & Enable Switch
CONTROLLER BREAKER	
UP	Single Phase A/C Mains applied to Controller Power Supply.
DOWN	Single Phase A/C Mains disconnected from Controller Power Supply.
ENABLE SWITCH	
NORMAL	Single Phase A/C Mains disconnected from Low Voltage Power Supply Breakers until transmitter is turned on.
STANDBY	Single Phase A/C Mains applied to Low Voltage Power Supply Breakers when transmitter is turned off.
LOW VOLTAGE BREAKER	
UP	Single Phase A/C Mains applied to Low Voltage Power Supply A.
DOWN	Single Phase A/C Mains disconnected from Low Voltage Power Supply A.
SERVO	
UP	Single Phase A/C Mains applied to Servo Power Supply.
DOWN	Single Phase A/C Mains disconnected from Servo Power Supply.

WARNING: Disconnect primary power prior to servicing.

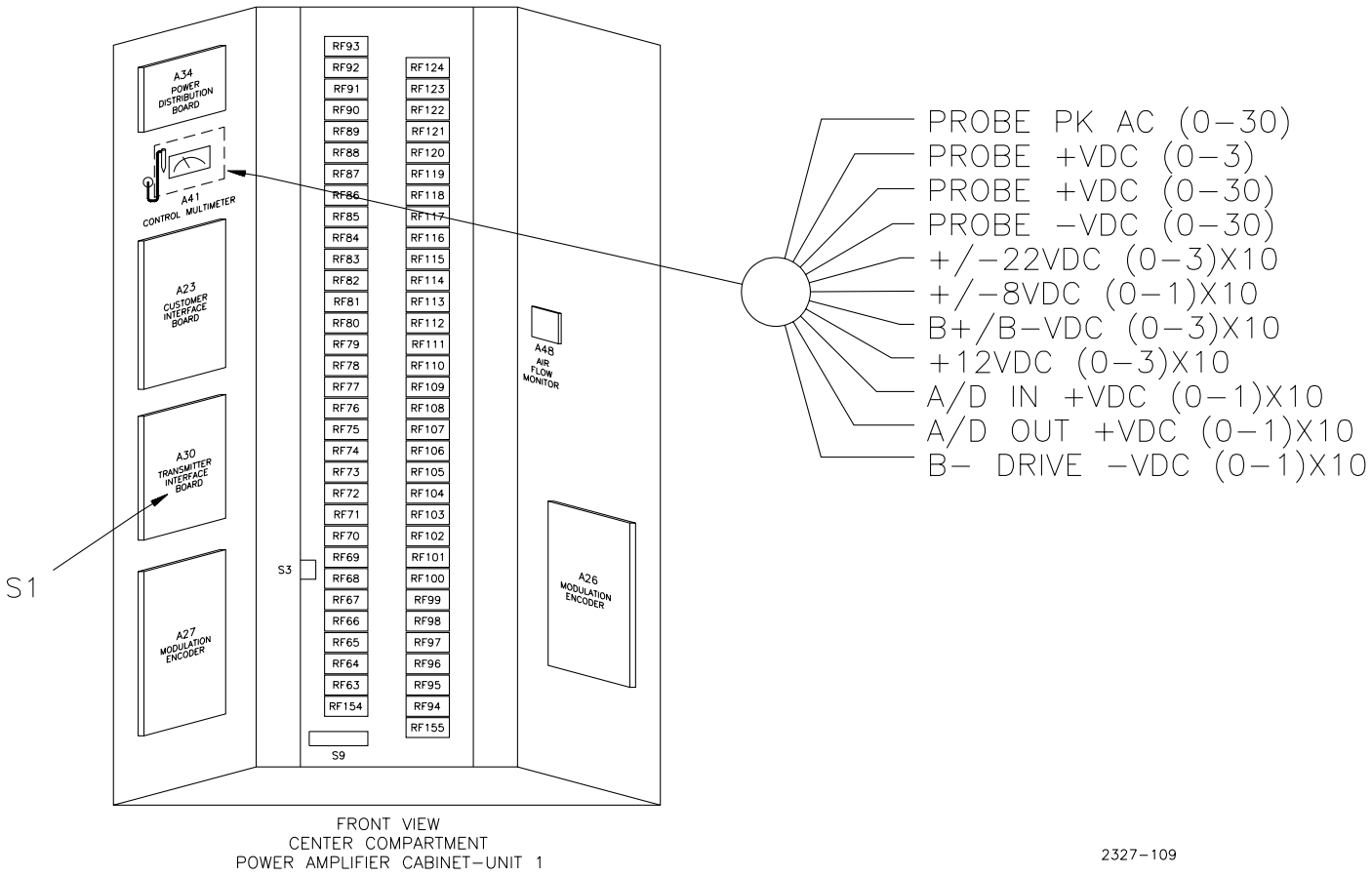

A34 POWER DISTRIBUTION BOARD
A41 CONTROL MULTIMETER
A23 CUSTOMER INTERFACE BOARD
A30 TRANSMITTER INTERFACE BOARD
A27 MODULATION ENCODER
A48 AIR FLOW MONITOR
A26 MODULATION ENCODER
S1
S3
S9
RF93 RF92 RF91 RF90 RF89 RF88 RF87 RF86 RF85 RF84 RF83 RF82 RF81 RF80 RF79 RF78 RF77 RF76 RF75 RF74 RF73 RF72 RF71 RF70 RF69 RF68 RF67 RF66 RF65 RF64 RF63 RF154
RF124 RF123 RF122 RF121 RF120 RF119 RF118 RF117 RF116 RF115 RF114 RF113 RF112 RF111 RF110 RF109 RF108 RF107 RF106 RF105 RF104 RF103 RF102 RF101 RF100 RF99 RF98 RF97 RF96 RF95 RF94 RF155
PROBE PK AC (0-30)
PROBE +VDC (0-3)
PROBE +VDC (0-30)
PROBE -VDC (0-30)
+/-22VDC (0-3)X10
+/-8VDC (0-1)X10
B+/B-VDC (0-3)X10
+12VDC (0-3)X10
A/D IN +VDC (0-1)X10
A/D OUT +VDC (0-1)X10
B- DRIVE -VDC (0-1)X10
FRONT VIEW
CENTER COMPARTMENT
POWER AMPLIFIER CABINET-UNIT 1
2327-109

Figure 3-5

Table 3-5

CONTROL MULTIMETER	
POSITION	FUNCTION
PROBE PK AC	Probe will measure peak alternating current voltages 0 to 30 Vac
PROBE +VDC	Probe will measure direct current voltages 0 to +3 Vdc
PROBE +VDC	Probe will measure direct current voltages 0 to +30 Vdc
PROBE -VDC	Probe will measure direct current voltages 0 to -30 Vdc
+/-22VDC	Normally measures the +22 Vdc power supply voltages 0 to +30 Vdc. When S1 on the transmitter interface is pressed and held down measures the -22 Vdc power supply voltage 0 to -30 Vdc
+/-8VDC	Normally measures the +8 Vdc power supply voltages 0 to +10 Vdc. When S1 on the transmitter interface is pressed and held down measures the -8 Vdc power supply voltage 0 to -10 Vdc
B+/B-VDC	Normally measures the B+ Vdc power supply voltages 0 to +30 Vdc. When S1 on the transmitter interface is pressed and held down measures the B- Vdc power supply voltage 0 to -30 Vdc
+12VDC	Measures the +12 Vdc power supply voltage 0 to +30 Vdc
A/D IN +VDC	Measures the audio +DC input to the A/D converter 0 to +10 Vdc
A/D OUT +VDC	Measures the reconstructed audio +DC output of the A/D converter 0 to +10 Vdc
B- DRIVE -VDC	Measures the B- drive signal out of the analog input 0 to -10 Vdc

WARNING: Disconnect primary power prior to servicing.

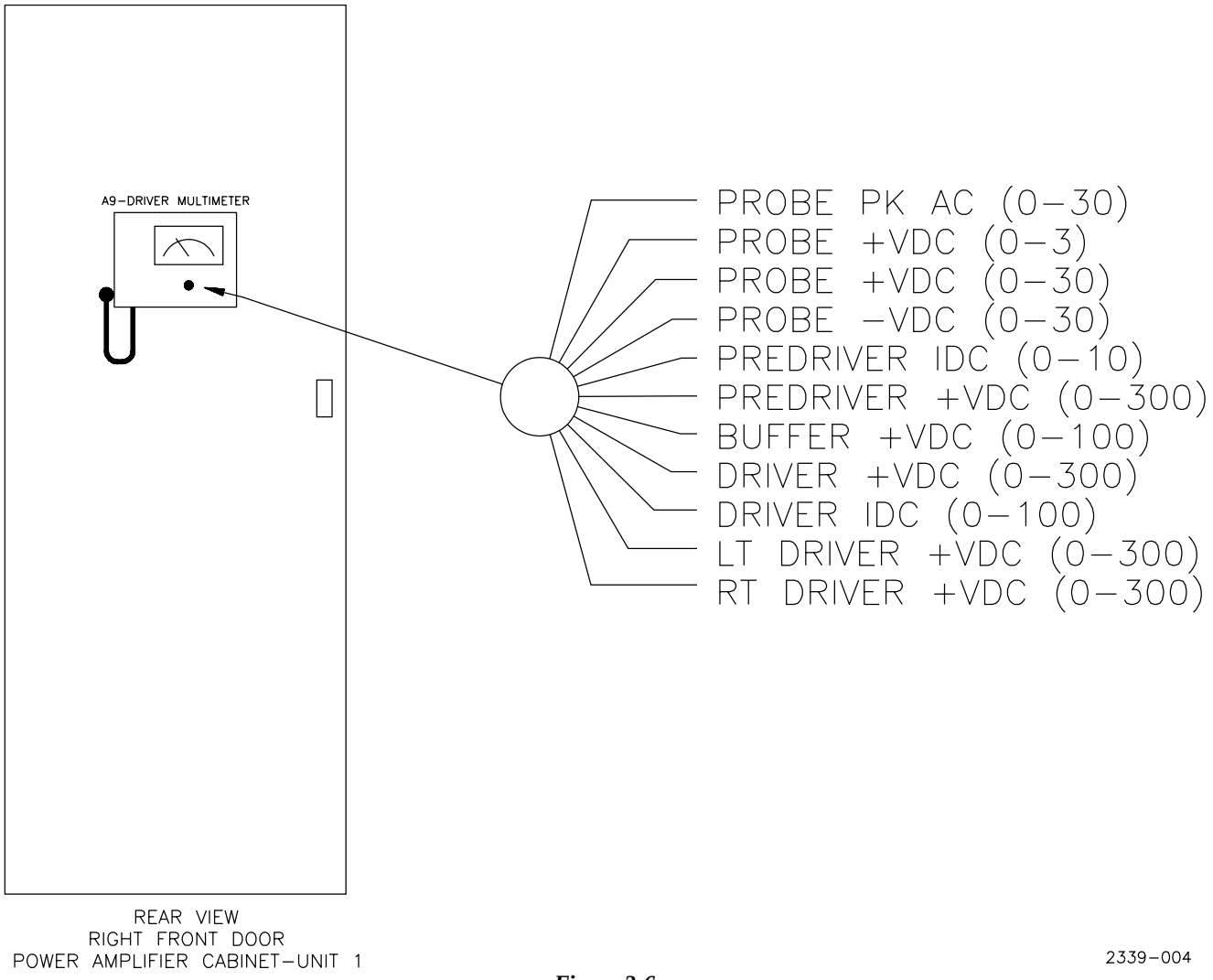


Figure 3-6

Table 3-6

DRIVER MULTIMETER	
POSITION	FUNCTION
PROBE PK AC	Probe will measure peak AC voltages 0 to 30 Vac
PROBE +VDC	Probe will measure positive direct current voltages 0 to +3 Vdc
PROBE +VDC	Probe will measure positive direct current voltages 0 to +30 Vdc
PROBE -VDC	Probe will measure negative direct currrent voltages 0 to -30 Vdc
PREDRIVER IDC	Measures Predriver current 0 to +10 A
PREDRIVER +VDC	Measures Predriver voltage 0 to +300 Vdc
CONTROL +VDC	Measures Driver Supply Regulator reference voltage 0 to 100 Vdc
DRIVER +VDC	Measures Driver Supply voltage 0 to 300 Vdc
DRIVER IDC	Measures Driver Supply current 0 to +100 A
DRIVER 14A +VDC	Measures Driver D14 “A” supply voltage 0 to +300 Vdc
DRIVER 14B +VDC	Measures Driver D14 “B” supply voltage 0 to +300 Vdc

WARNING: Disconnect primary power prior to servicing.

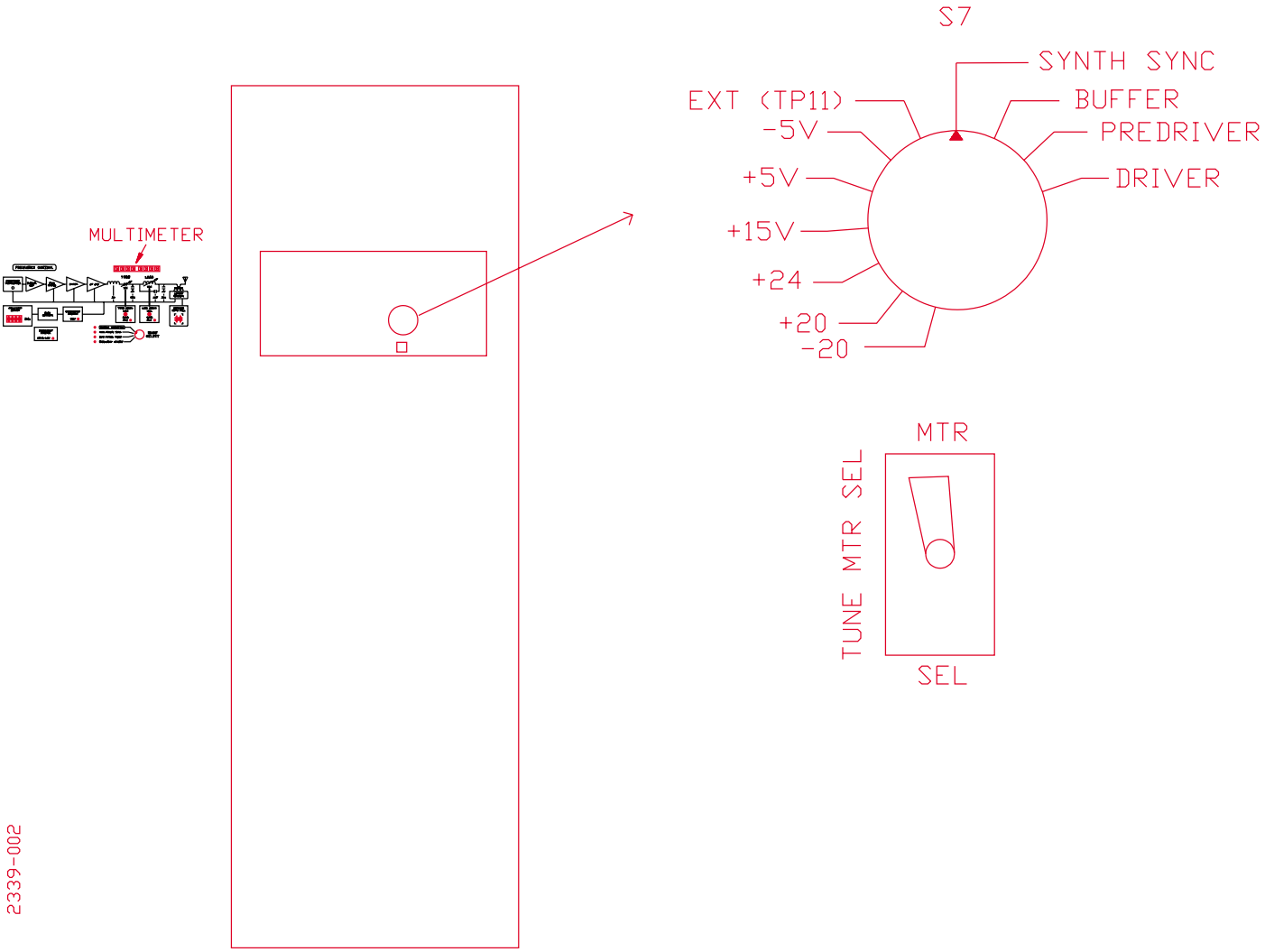


Figure 3-7

Table 3-7

FREQUENCY CONTROL POSITION	MULTIMETER FUNCTION
-20	Measures transmitter -20Vdc power supply
+20	Measures transmitter +20Vdc power supply
+24	Measures transmitter +24Vdc power supply
+15V	Measures Frequency Control board +15Vdc power supply
+5V	Measures Frequency Control board +15Vdc power supply
-5V	Measures Frequency Control board +15Vdc power supply
EXT(TP11)	Measures any voltage connected to TP11
SYNTH SYNC	Measures relative phase difference between the Synthesizer output and Synthesizer sync signal
BUFFER	Measures relative RF output of the Buffer Amplifier
PREDRIVER	Measures relative RF output of the Predriver Amplifier
DRIVER	Measures relative RF output of the Driver section

WARNING: Disconnect primary power prior to servicing.

DX100-3F ROUTINE METER READINGS			
DATE			
TEST CONDITIONS:			
MODULATION:			
FREQUENCY			
POWER LEVEL	**LOW**	**MEDIUM**	**HIGH**
FRONT PANEL METERS			
FORWARD POWER			
REFLECTED POWER			
PA CURRENT			
FRONT PANEL MULTIMETER			
PA VOLTS			
NETWORK NULL			
ANTENNA NULL			
RF DRIVE			
FREQUENCY CONTROL METERS			
TUNE SERVO			
LOAD SERVO			
-10			
+20			
+24			
+15V			
+5V			
-5V			
EXT (TP11)			
SYNTH SYNC			
BUFFER			
PREDRIVER			
DRIVER			
CONTROL MULTIMETER			
-22V			
+22V			
-8V			
+8V			
B+			
B-			
+12V			
A/D INPUT			
A/D OUTPUT			
B- DRIVE			
DRIVER MULTIMETER			
PREDRIVER CURRENT			
PREDRIVER VOLTAGE			
BUFFER VOLTAGE			
DRIVER SUPPLY VOLTS			
DRIVER SUPPLY CURRENT			
LEFT DRIVER VOLTS			
RIGHT DRIVER VOLTS			

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

4.1 Introduction

This section of the maintenance manual will present the overall principles of operation for the transmitter, including a description of circuits not included on circuit boards described in sections A through R of this Technical Manual.

This section is organized as follows:

- Block Diagram Description
- Digital Modulation Process
- Protection of Personnel
- Transmitter Protection
- RF Circuits in the Transmitter
  - RF Driver Combiner
  - Output Network
- AC Power Circuits in the Transmitter
  - Low Voltage Power Supply
  - RF Amp Power Supply
  - Servo Power Supply
- Driver Multimeter
- Control Multimeter

4.2 Block Diagram Description

If you refer to Figure 4-1, the Transmitter Block Diagram, you can see that there are two signal paths to the RF Amplifier section. One is an RF signal path, and the other is a digital audio signal path.

Most of the blocks on the block diagram represent printed circuit boards in the transmitter.

4.2.1 RF Section

The RF Section includes the Synthesizer Interface through the Output Network.

The RF Section generates an RF signal, then amplifies the signal to a level adequate to drive the RF Amplifier stage. The RF Amplifier outputs are combined and go through a Bandpass Filter/Output Matching Network to the 50 ohm RF output connector.

4.2.1.1 Synthesizer Interface

The RF signal path begins at the Synthesizer Interface board with a frequency synthesizer module or it can be brought in externally from another source. The most common uses of the external input are AM Stereo or combined transmitter operations. A second Synthesizer Interface board is available as an option.

4.2.1.2 RF Interface

The RF Interface selects which Frequency Synthesizer is to be used to supply the transmitter. Its output drives the Buffer Amplifier.

4.2.1.3 Buffer Amplifier

The plug in Buffer Amplifier module amplifies the RF Interface output from a TTL level to approximately 20 Vp-p. There are two separate amplifiers on the Buffer amplifier module. Buffer A and Buffer B are driven in parallel.

4.2.1.4 Predriver

The Predriver amplifies the Buffer signal to a level adequate to drive the 14 RF Amplifiers used in the RF Driver. There are two Predrivers, Predriver A and Predriver B. Only one of the Predrivers is active at any one time. The Predriver module is interchangeable with the 14 Driver RF Amplifiers, and any of the 160 Big Step and Binary RF Amplifiers.

4.2.1.5 Predriver Tuning

The Predriver Tuning board resonates the active Predriver output and provides RF drive to the next stage.

4.2.1.6 RF Drivers

Up to 14 RF Drivers are used in the transmitter to amplify the RF signal from the Predriver to provide the proper RF drive level for the 160 Big Step and Binary RF Amplifiers. These 14 RF Drivers are interchangeable with any of the 160 RF Amplifiers and the Predriver.

4.2.1.7 Driver Combiner

The outputs from the RF Drivers are combined in the Driver Combiner. Each RF Driver feeds its own combiner transformer and the outputs are added together by a copper pipe and connected to the RF Splitter.

4.2.1.8 Driver Tuning

Driver Tuning resonates the RF Driver output.

4.2.1.9 RF Splitter

The purpose of the RF Splitter is to divide the combined output of the Driver Combiner and provide each RF Power Amplifier with the proper RF drive level.

4.2.1.10 Driver Encoder

The Driver Encoder provides the control signals for the Predriver, and RF Drivers D1-D14. The switch for Buffer/Predriver A or Buffer/Predriver B is located on this board. The Driver Encoder board also contains Buffer, Predriver, and High/Low Fault Sense & metering circuitry.

4.2.1.11 RF Power Amplifiers

The RF Power Amplifiers consists of 160 plug-in modules. Encoded audio signals from the Modulation Encoder turn on as many RF Amplifiers as required at any instant by the required carrier level and the modulating signal. Of the 160 RF Amplifiers, 156 are Big Step Amplifiers and 4 are Binary Amplifiers. The method of digital modulation employed in the transmitter uses a combination of whole Big Steps and fractional Binary Steps.

4.2.1.12 Main Combiners and Binary Combiner

9 Main Combiners and 1 Binary Combiner make up the PA Combiner. The output of each RF Power Amplifier Big Step or Binary step feeds its own combiner transformer and the outputs are added together and connected to the Output Network.

4.2.1.13 Output Network

The Output Network transforms the impedance of the PA Combiner output, at about 8 Ohms, to 50 Ohms. This is done in two

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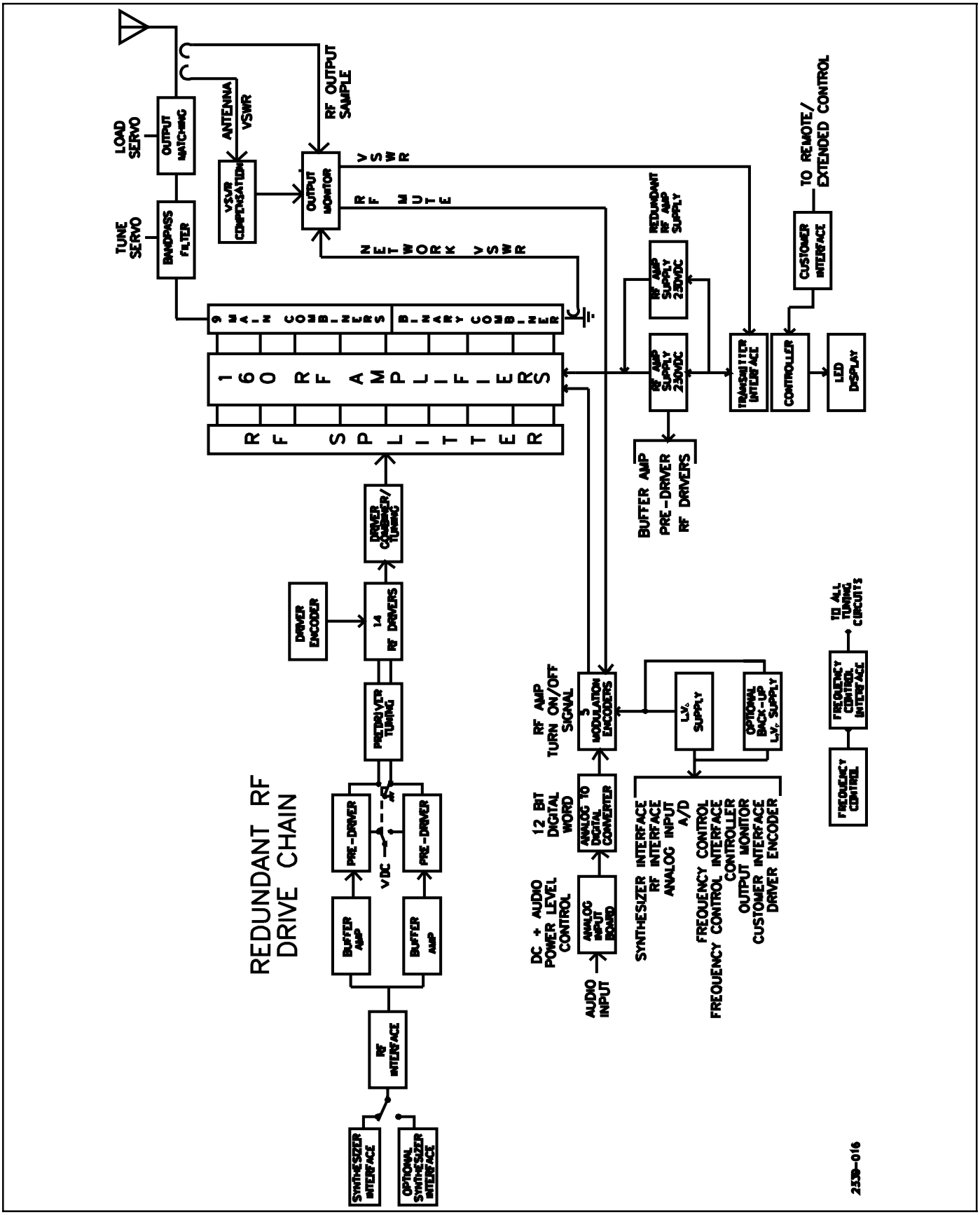

Figure 4-1. Overall Block Diagram

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basic sections, the Bandpass Filter stage and the Output Matching stage.

4.2.1.14 Output Monitor

The Output Monitor detects any high VSWR condition in the Output Network and/or Antenna. If the VSWR is high enough, the Output Monitor board will generate an RF Mute that will turn all RF Power Amplifiers OFF momentarily; then resume operation. If the high VSWR persists, the transmitter will foldback power to a safe operating level and return to normal power if the VSWR condition was temporary. For continuing severe VSWR, the transmitter will shut off.

4.2.2 Modulation Section

The purpose of the modulation section is to turn on and turn off the RF Amplifiers as required to create the proper carrier and modulation level simultaneously.

4.2.2.1 Audio Input

Audio is fed into the Analog Input board where it is added to a DC component which is used to determine the carrier power. A power control attenuates or increases the Audio + DC signal to provide HIGH, MEDIUM and LOW RF power output (as well as Fine power control). The audio + DC signal is then sent to the A/D Converter.

4.2.2.2 Analog To Digital Converter

The A/D (ANALOG TO DIGITAL) Converter board converts the Audio + DC signal into a 12 bit digital audio signal.

4.2.2.3 Modulation Encoders

The 5 Modulation Encoders convert the 12-bit digital audio information into control signals which turn the PAN RF power amplifier modules on and off, as required to maintain the transmitter carrier power level and the instantaneous modulation level.

4.2.3 Control Section

The Control section consists of the Controller board, LED board, and External Interface board.

4.2.3.1 Controller

The Controller provides transmitter turn on and turn off functions, fault and overload sensing, and executes operations to protect the transmitter as necessary.

4.2.3.2 LED Board

The LED Board provides visual LED status indications. All status indications are latched, to provide fault indications until they are reset, even if the transmitter is turned off.

4.2.3.3 External Interface

The External Interface provides remote control inputs, status outputs, and selected metering outputs.

4.2.3.4 Frequency Control Board

The Frequency Control board is basically a control, metering, and status panel for the frequency agile transmitter. It provides front panel control of the transmitter frequency, mode of operation, and other fine adjustments of transmitter tuning and loading. Status indicators are used for reporting of frequency mode and fault status, while multimeters indicate servo voltages required for tuning and loading.

4.2.3.5 Frequency Control Interface

The function of the Frequency Control Interface board is to take the Band Select Data and use this information to switch the appropriate components for the desired frequency. This board performs both binary weighted switching of relays and servo controlled adjustment of the tuning and loading of the transmitter for fine tuning. Also on this board is the fault circuitry for protecting the transmitter in case of a bandswitch or servo fault along with the required control logic for operating the transmitter during frequency change and subsequent tune up.

4.2.4 Power Supplies

The power supplies section includes the low voltage supplies, servo supplies, and the RF Amplifier power supplies.

4.2.4.1 Low Voltage Power Supplies

The voltages generated are + and -8VDC, + and -12VDC (unregulated B+ and B-), + and -22VDC. The Controller has its own separate 12VDC supply. All of the printed circuit boards in the transmitter operate from the low voltage supplies.

4.2.4.2 Servo Supplies

The voltages generated are +24VDC and + and -20VDC. All of the bandswitching relays and servos operate from these supplies.

4.2.4.3 RF Amplifier Power Supplies

The voltages generated are +230VDC, +115VDC, and +60VDC. The Buffer, Predriver, RF Drivers, and RF Amplifiers operate from the RF Amplifier power supplies.

4.2.5 Digital Modulation Overview

A general review of the Digital Modulation process is included here for users that may not be familiar with this technology.

The amplitude modulation process in the transmitter takes place in three steps.

1. The audio input signal is converted into a series of 12 bit digital words, in an Analog to Digital Converter. This digital data stream is a “digital audio” signal.
2. The digital data stream from the A/D Converter is changed by the Modulation Encoder into on/off commands to the 160 RF Power Amplifiers.
3. The individual RF Power Amplifier outputs are summed in the RF Power Combiner. The amplitude of the RF output signal is varied higher or lower by the number of RF Power Amplifiers switched on according to the incoming digitized audio signal. This is Digital Amplitude Modulation.

Refer to Figure 4-2, A/D-D/A for the following discussion.

4.2.6 Digital Modulation In More Detail

4.2.6.1 A/D Conversion

The Analog to Digital (A/D) Conversion process takes place in two steps. First, the amplitude (voltage) of the input signal is sampled. Secondly, for each sample a digital word (i.e 101001000001) is constructed that represents the input signal.

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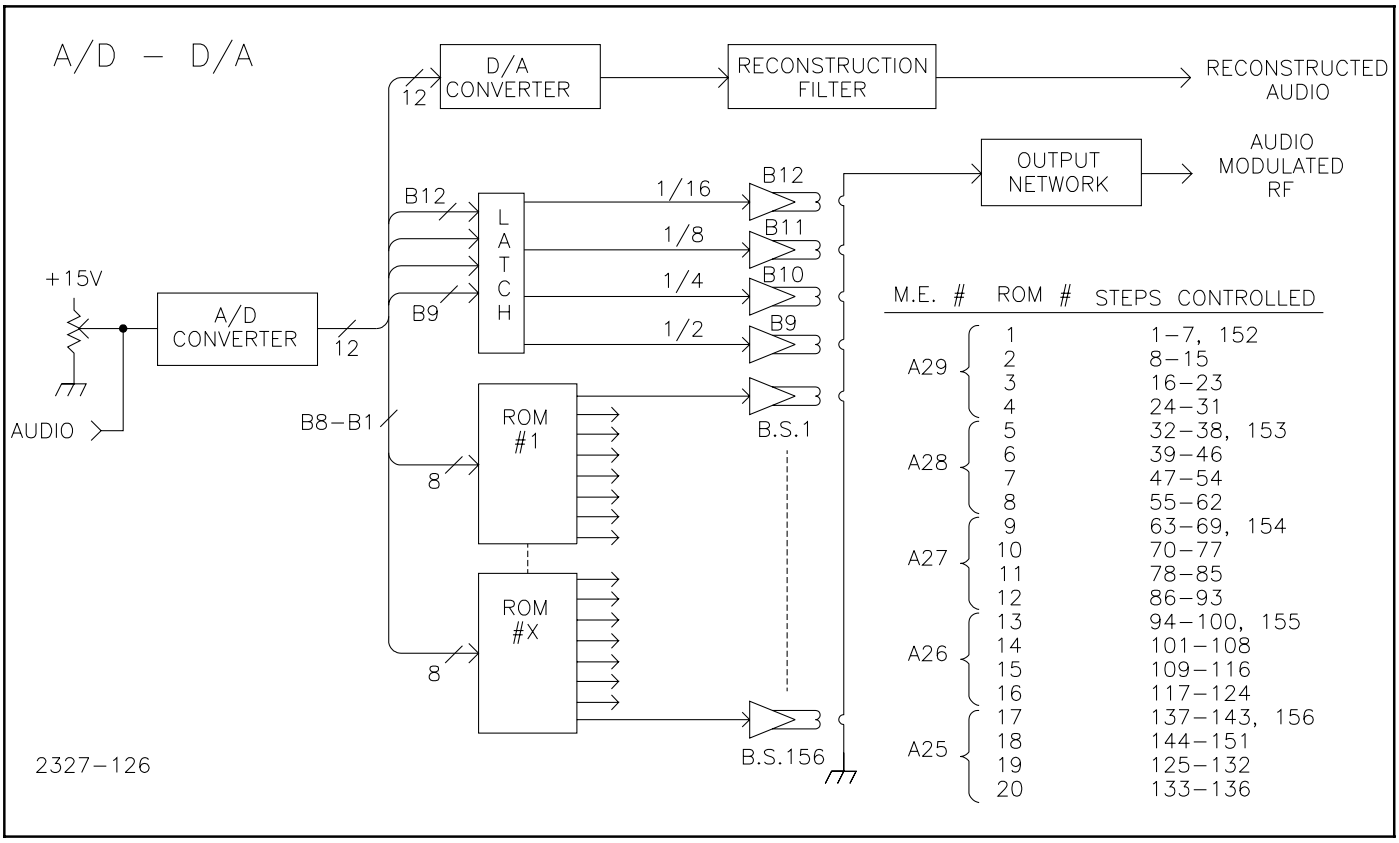

Figure 4-2. A/D-D/A

4.2.6.1.1 A/D Input - Audio And DC Voltage

The input signal to the A/D Converter is a combination of a positive DC voltage (presented on the wiper of the potentiometer) and the audio input.

4.2.6.1.2 A/D Output - Digital Audio Signal

The digital audio signal consists of a stream of 12-bit digital words on the 12 outputs of the A/D Converter. The 12 bits are referred to as B1 through B12, where B1 is the Most Significant Bit (MSB) and B12 is the Least Significant Bit (LSB).

4.2.6.2 Modulation Encoding

The control signals from the Modulation Encoder Latch and ROM outputs turn the 160 Big Step and Binary RF Amplifiers on and off. Each digital word consists of two groups of information to be encoded, B1 through B8 and B9 through B12.

4.2.6.2.1 Bits 9-12, Binary Step Control

The 4 fractional Binary Step RF Amplifiers are directly controlled by bits B9-B12, via Latches. B9 controls the 1/2 Step, B10 controls the 1/4 Step, B11 control the 1/8 Step, and B12 controls the 1/16 Step.

4.2.6.2.2 Bits 1-8, Big Step Control

The 156 equal Big Step RF Amplifiers are directly controlled by the bits B1-B8, via ROM #1 through ROM #20. The eight MSB of the digital word address memory locations in each of the ROM's, and the information stored in each ROM memory location turns on the required Big Step RF Amplifier. Each ROM has eight outputs and therefore controls eight Big Steps, the chart lists the ROM # and the Steps Controlled.

4.2.6.2.3 A/D Converter Output Chart

Refer to Figure 4-3, A/D Converter Output Chart for the following discussion.

The top of the chart lists the 12 outputs B12 through B1 of the A/D Converter and the RF Amps turned "ON". With 0VDC at the input of the A/D Converter, the first line shows that all outputs will be 0 or a logic low and no RF Amplifiers are on.

1. As the input voltage begins to go slightly positive (by turning the potentiometer), B12 will be 1 or a logic high and the latch will turn on the 1/16 Step.
2. If the input goes more positive, B12 will go to 0 and B11 will be 1. The 1/16 Step will turn off and the 1/8 Step will turn on.
3. If the input goes more positive, both B12 and B11 will be 1, and both the 1/16 and 1/8 Steps will be turned on.
4. As the input continues to increase, the digital audio signal will continue to count up in a binary fashion until, B12 through B9 will be 1 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned on.
5. If the input goes more positive, B12 through B9 will be 0 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned off. B8 will be 1, and the first output from ROM #1 will turn on Big Step #1.

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(MSB)											(LSB)	RF
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	AMPS
												ON
128	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	(DECIMAL EQUIVALENT)
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	1	1/16
0	0	0	0	0	0	0	0	0	0	1	0	1/8
0	0	0	0	0	0	0	0	0	0	1	1	1/16+1/8
0	0	0	0	0	0	0	0	0	1	0	0	1/4
0	0	0	0	0	0	0	0	0	1	0	1	1/16+1/4
0	0	0	0	0	0	0	0	0	1	1	0	1/8+1/4
0	0	0	0	0	0	0	0	0	1	1	1	1/16+1/8+1/4
0	0	0	0	0	0	0	0	1	0	0	0	1/2
0	0	0	0	0	0	0	0	1	0	0	1	1/16+1/2
0	0	0	0	0	0	0	0	1	0	1	0	1/8+1/2
0	0	0	0	0	0	0	0	1	0	1	1	1/16+1/8+1/2
0	0	0	0	0	0	0	0	1	1	0	0	1/4+1/2
0	0	0	0	0	0	0	0	1	1	0	1	1/16+1/4+1/2
0	0	0	0	0	0	0	0	1	1	1	0	1/8+1/4+1/2
0	0	0	0	0	0	0	0	1	1	1	1	1/16+1/8+1/4+1/2
0	0	0	0	0	0	0	1	0	0	0	0	B.S. 1
0	0	0	0	0	0	0	1	0	0	0	1	B.S. 1+1/16
0	0	0	0	0	0	0	1	0	0	1	0	B.S. 1+1/8
0	0	0	0	0	0	1	0	0	0	0	0	B.S. 1+2
0	0	0	0	0	0	1	1	0	0	0	0	B.S. 1+2+3
0	0	0	0	0	1	0	0	0	0	0	0	B.S. 1+2+3+4

Figure 4-3. A/D Converter Output Chart

WARNING: Disconnect primary power prior to servicing.

6. If the input goes more positive, B8 will remain 1 and B12 will go from 0 to 1. Big Step #1 and the 1/16 Step will be on.
7. As the input continues to increase, the digital audio signal will continue to count up in a binary fashion until, B12 through B8 will be 1 and Big Step #1 and the 1/16, 1/8, 1/4, and 1/2 Steps are all turned on.
8. If the input goes more positive, B12 through B8 will go to 0 and B7 will be 1. The 1/16, 1/8, 1/4, and 1/2 Steps will all turn off, however the first output of ROM #1 will keep Big Step #1 on and the second output from ROM #1 will turn on Big Step #2. The important point to note is that the ROMs basically convert B1-B8 into the Big Step decimal equivalent. B8 is the 1's column, B7 is the 2's, B6 is the 4's, B5 is the 8's, B4 is the 16's, B3 is the 32's, B2 is the 64's, and B1 is the 128's column (as shown on the chart).

For example, if B12 through B1 respectively was 0000/00000010, ROMs 1 through 9 would recognize this as having a decimal equivalent of 64 and signals would go out to the first 64 equal Big Step RF Amplifiers turning them on. This occurs when the A/D Converter input voltage is approximately 2.0VDC and is the 100 kW carrier condition.

If B12 through B1 respectively was 1111/00111001, ROMs 1 through 20 would recognize this as having a decimal equivalent of 156 and signals would go out to all 156 equal Big Step RF Amplifiers turning them on. The latch will also turn on the 1/2, 1/4, 1/8, and 1/16 fractional Binary Step RF Amplifiers. This occurs when the A/D Converter input voltage is approximately 5.0VDC and is the maximum power output obtainable.

4.2.6.3 RF Power Combiner

The RF Power Combiner sums all the individual Power Amplifiers into a single amplitude modulated RF output.

4.2.6.3.1 RF Power Amplifier Combiner

The summing or combining of the individual PA modules is done by a multi-turn primary/single turn secondary transformer/combiner. Each RF Power Amplifier is connected to its own toroid. The secondary of this circuit is a copper rod which is connected to ground on one end and to the Output Filter on the other end. The RF energy is coupled by the multi-turn primary toroids to the single turn secondary (copper rod). The copper rod passes through the center of the toroids, receives the RF energy and carries it to the Bandpass Filter.

The RF voltage is low or zero at the ground point of the secondary rod and increases along the way to the Output Network.

The dual action of the combiner and Big Step RF Amplifiers produces EQUAL RF VOLTAGE steps at the output, not RF power steps. Switching on twice as many Big Step RF Amplifiers will produce twice the RF VOLTAGE output (and four times the power output).

The Binary RF Amplifiers produce FRACTIONAL RF VOLTAGES when compared to the Big Steps. The 1/2 Step produces 1/2 the RF voltage of a Big Step, the 1/4 Step produces 1/4 the RF voltage of a Big Step, the 1/8 Step produces 1/8 the RF voltage of a Big Step, and the 1/16 Step produces 1/16 the RF voltage of a Big Step. The Binary Amplifiers are the same RF modules as used in the Big Step RF Amplifiers however the fractional Big Step voltage is obtained by running the modules at lower DC voltage and by using a different turns ratio on their toroids.

4.2.6.3.2 Bandpass Filter and Output Matching

The RF output of the Combiner then passes through a series tuned Bandpass Filter which smooths the digitally created AM signal so that the AM signal is now identical to a standard analog AM signal except for its improved quality. From the Bandpass Filter the AM signal goes through an Output Matching Network and third harmonic filter. The output Matching Network allows the transmitter to match loads up to 1.2:1 to 1:1 for a nominal 50 ohm output.

4.2.6.3.3 Digital Amplitude Modulation Summary

Any desired transmitter output from zero to 110 kW can be produced by turning on the appropriate number of equal RF voltage Big Step and fractional RF voltage Binary RF Amplifiers. Turning more RF Amplifiers on increases the transmitter's RF output, normally 64 Big Step RF Amplifiers are turned on for 100 kW RF output.

Refer to the Modulation Encoder Counting Order Diagram (843-5155- 162) and VIEWS 10, 12, and 14 in Section VA for the following discussion.

Each of the 156 Big Step RF Amplifiers is numbered, from RF1 thought RF156 and the Binary Step RF Amplifiers are numbered B9 (1/2) through B12 (1/16).

The Big Step RF Amplifiers turn on in the following sequence from 0 to full output power.

1. Left side of left compartment, second from the bottom to the top, RF1 through RF31.
2. Right side of left compartment, second from the bottom to the top, RF32 through RF62.
3. Left side of center compartment, second from the bottom to the top, RF63 through RF93.
4. Right side of center compartment, second from the bottom to the top, RF94 through RF124.
5. Left side of right compartment, from the bottom to the top, below the Binary Steps, RF125 through RF136.
6. Right side of right compartment, second from the bottom to the middle, RF137 through RF151.
7. The bottom of the left and right sides of the left (RF152/RF153) and center (RF154/RF155) compartments, & the bottom right side of the right compartment RF156, respectively.

4.2.6.3.4 Audio Modulation

Refer to Figure 4-4, Digital AM Modulation for the following discussion.

If an audio signal is summed together with the DC voltage at the A/D input and begins to increase, more RF Amplifiers will be turned on. If the audio signal decreases, some of the RF Amplifiers will be turned off. As the audio signal changes from instant

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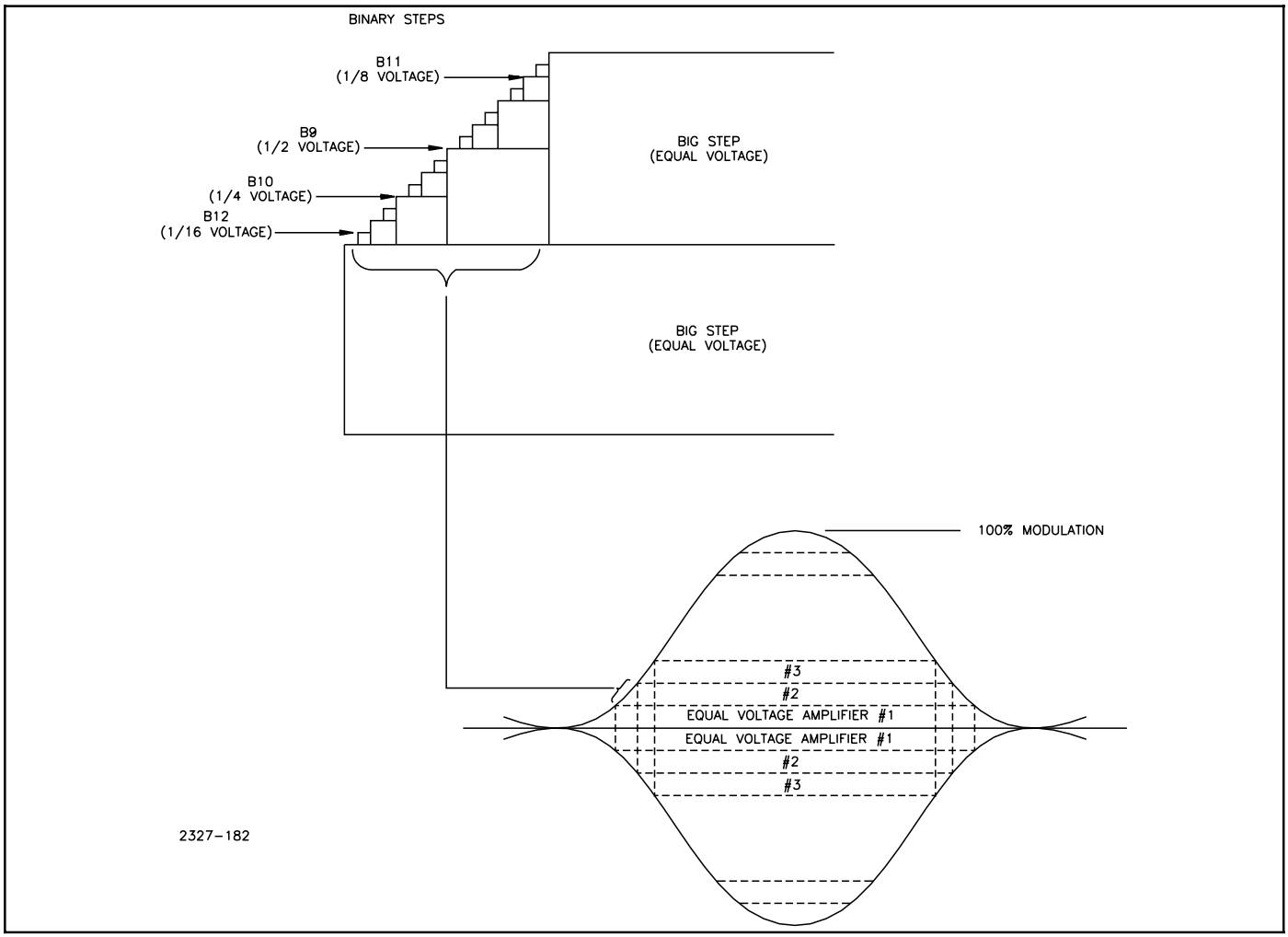

Figure 4-4. Digital AM Modulation

to instant, the number of RF amplifiers that are switched on also changes.

For a positive modulation peak, which requires a high RF voltage (and power) at the transmitter output, a large number of RF Amplifiers are turned on. For a 100% negative modulation peak, which corresponds to zero transmitter RF voltage (and power) output, all the RF Amplifiers are turned off.

An important point to note is that the transmitter reaches it's positive peak modulation capability when all the RF Power Amplifiers are turned on and it's negative peak (-100%) when all the modules are turned off.

4.2.6.4 *Conclusion*

The transmitter uses Digital Amplitude Modulation for superior audio performance and highest AC to RF efficiency.

Digital Amplitude Modulation is created by a two step process.

1. Audio +DC (carrier level) is converted into digital words by an A/D Converter.
2. The digital words are used to turn on/off the 160 RF Power Amplifiers which create amplitude variations of the RF according to the incoming audio signal and carrier set level.

The peak positive modulation of the transmitter occurs when all 160 RF Power Amplifiers are turned on.

The peak negative modulation (-100%) occurs when all the RF Power Amplifiers are turned off.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

4.3 Protection Of Personnel

The following is a list of protection devices installed in the transmitter designed for the safety of maintenance personnel. It

includes a brief discussion of each device and references to other sections of this manual where applicable.

4.3.1 Doors And Panels

Inner front and rear access doors and panels are secured with quarter-turn fasteners, and tools are required to remove them.

4.3.2 Door Interlocks

Interlock switches have been installed on the inner front doors and the rear hinged doors of the transmitter, all panels of the power supply and the front panel and rear door of the output cabinet. Control circuits will turn the transmitter OFF if any interlocked door is opened. The transmitter must be manually turned on again after the door is properly closed. For a description of interlock circuits and logic, refer to Section P, Transmitter Interface board, and Section M, Controller board.

4.3.3 External Interlock

The External Interlock will turn off the transmitter the instant the interlock continuity is opened. The External Interlock circuit requires that the transmitter be turned back on manually after an interruption. Refer to Section N, External Interface.

4.3.4 RF Amplifier Power Supply Discharging

The RF Amplifier Power Supply consists of the +230 VDC, +115 VDC, and +60 VDC supplies. Each electrolytic supply filter capacitor for these supplies has its own discharge resistor mounted directly across the terminals of the capacitor. The +230VDC and +115VDC supplies are also discharged by the Crowbar Assembly, which connects these supplies to ground through 2.5 Ohms of resistance whenever the OFF button is depressed or the transmitter shuts itself off. Refer to the Crowbar circuit description later in this section.

4.3.5 Mechanical Shorting Switches

When an inner front door or a rear hinged door is opened, heavy mechanical shorting switches in parallel with the crowbar circuit provide a direct path from the +230 Volt supply to ground.

4.4 Transmitter Protection

The following is a list of protection devices installed in the transmitter. They are designed to protect the transmitter from undesirable external conditions. It includes a brief discussion of each device.

4.4.1 A/C Transients

MOVs (metal oxide varistors) are used to absorb transient voltages on the incoming ac lines. Two are used on the single phase feed, and three are placed across the 3-phase lines.

4.4.2 3 Phase AC Undervoltage And Loss Of Phase

An A/C line monitor K10 is connected to the 3 PH A/C input. This monitor will turn off the transmitter in the event of a phase imbalance of 8% or greater, or if the incoming voltage is 20% less than the specified input.

4.4.3 3 Phase AC Overvoltage

If the 3 Phase A/C incoming voltage is too high, circuits that monitor the RF Amplifier Power Supply +230VDC will turn off the transmitter.

4.4.4 Single Phase AC Undervoltage And Overvoltage

IC voltage regulators on printed circuit boards include protection against low regulated output voltages.

4.4.5 Air Flow Monitors

Dirty or clogged air filters, backpressure, or loss of a fan will reduce air flow and therefore reduce cooling. Air Flow Monitors are located in the Output cabinet, and Left, Center, and Right PA Compartments. If the reduction of air flow is enough, the transmitter will continually foldback power output until a safe operating level is reached. If air flow reduction is severe enough, the transmitter will shut OFF.

4.4.6 Spark Gap

A spark gap at the transmitter's RF output protects the transmitter against high transient voltages caused by lightning or electrostatic discharge.

4.4.7 ARC Detectors

An upper ARC detector and lower ARC detector monitor the two sections of the Output Network. Should an ARC occur, the fault is treated exactly as a Network VSWR fault.

4.4.8 Discharge Ground

In the lower rear and upper front of the output network, discharge sticks are provided for ensuring that any residual voltages have been depleted. The discharge sticks should be removed from their respective mechanical clamps and used to short to ground capacitors and other assemblies that may have collected an electrical charge.

4.4.9 VSWR

If high VSWR is detected in the Network or Antenna, the transmitter will foldback power until a safe operating level is reached. If the VSWR is severe, the transmitter will shut off.

4.4.10 Temperature Sensing

Temperature sensors are attached to the heat sink of RF Amplifier, RF1, and the rectifier heatsinks in the RF Amp Power Supply. If the ambient air intake temperature increases above 70 degrees C, or the transmitter is severely mistuned, the heat sink temperature will also increase. If the output of the sensor rises above the preset threshold, the transmitter will foldback power to a safe operating range. If the temperature increase is severe, the transmitter will shut off.

4.5 RF Circuits In The Transmitter

4.5.1 RF Driver Section

The RF Driver section receives from the RF Interface board a 5Vp-p input signal (at the transmitter's operating frequency). The

WARNING: Disconnect primary power prior to servicing.

RF Driver section includes three basic stages of amplification. This is to provide enough RF drive for the 160 Big Step and Binary RF Amplifiers. The section normally operates below its capacity, and is capable of providing the additional RF drive when required.

The RF Driver section is contained in the Right PA compartment. The components that make up the section are located in the top half and in the rear of this compartment behind interlocked doors.

See VIEWS 10 & 15 for a more exact location of the components.

NOTE - The following sections describe the RF signal flow in general, for more detail refer to the Buffer Amplifier, Predriver, and RF Drivers in Section C, Driver Combiner Motherboard.

Refer to Figure 4-5, RF Driver Section for the following discussion.

4.5.1.1 Buffer Amplifier

The plug in Buffer Amplifier amplifies the RF Interface output from a TTL level to approximately 20 Vp-p. There are two separate amplifiers on the Buffer Amplifier board, Buffer A and Buffer B, which are driven in parallel. Buffer A output drives Predriver A, while Buffer B output drives Predriver B. Buffer A and Buffer B are both active at the same time. However, only one of the Buffers is in the RF chain at any one time. The use of Buffer A or Buffer B is selected by the Predriver A/Predriver B control on the Driver Encoder board.

4.5.1.2 Predriver RF Amplifier

The Predriver amplifies the Buffer signal to a level adequate to drive the 14 Driver RF Amplifiers via the Predriver Tuning board. There are two Predrivers, Predriver A and Predriver B, which are constantly being driven by their respective Buffer Amplifier output. Only one of the Predrivers is active at any one time. Predriver A or Predriver B is selected on the Driver Encoder board.

The Predriver RF Amplifier, the 14 Driver RF Amplifiers and the 160 Big Step and Binary RF Amplifiers are fully interchangeable.

4.5.1.3 Predriver Tuning

The input of the Predriver Tuning board is driven by the Predriver Amplifier. The selected Predriver RF output passes through a series-tuned inductive/capacitive network and the primary windings of the transformer on the Predriver Splitter. The value of inductance and capacitance is frequency determined. This board also controls the Predriver voltage by relay contacts across dropping resistor R1.

4.5.1.4 Predriver Splitter A46 and Driver Drive Cables

The secondary of the Predriver Splitter divides the RF signal and drives the 14 Driver RF Amplifiers, D1-D14. There are 4 connectors on the outside of the splitter to which the Driver Drive Cables connect. The other end of these cables connect to the Driver Combiner Motherboard.

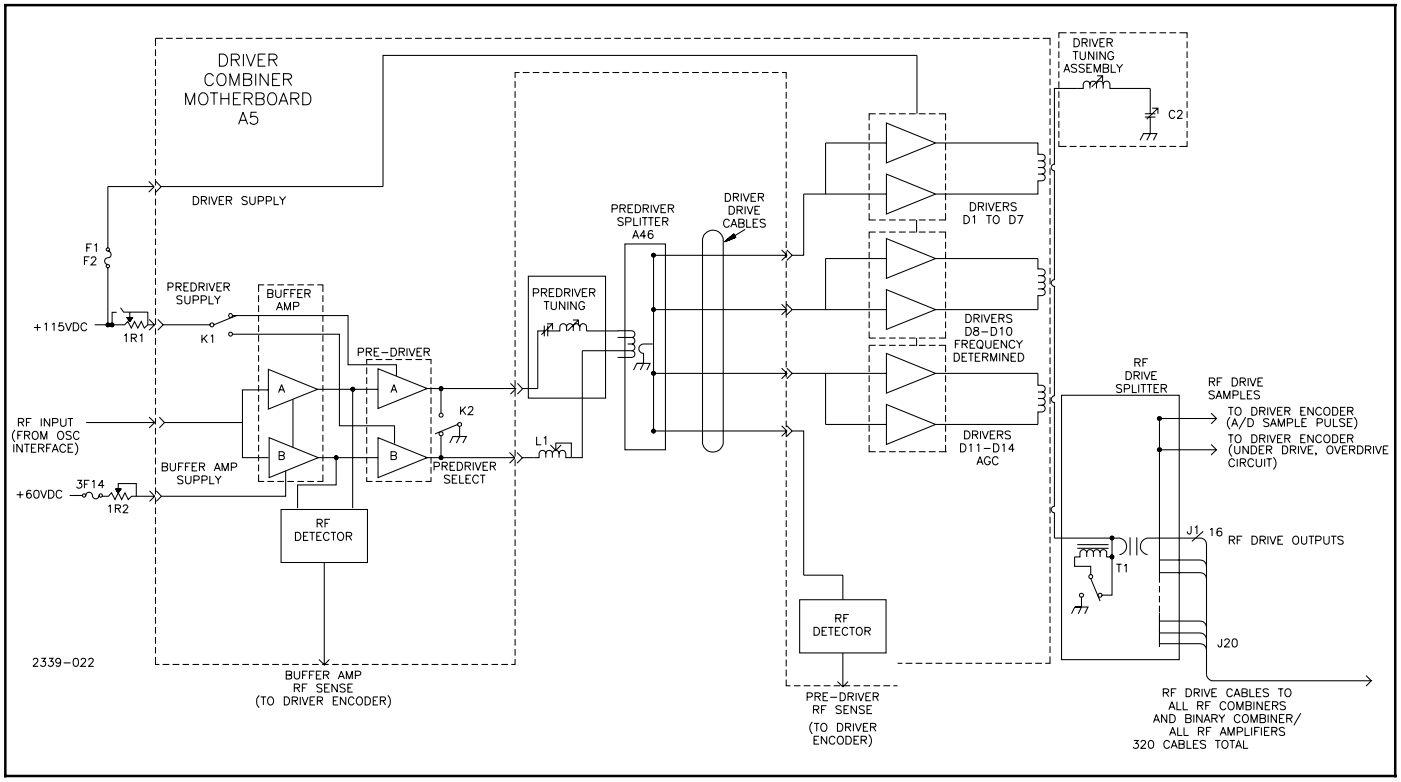

Figure 4-5. RF Driver Section

WARNING: Disconnect primary power prior to servicing.

4.5.1.5 RF Drivers

The RF Driver consists of fourteen Driver RF Amplifiers, D1 through D14. The RF drive inputs are from the Predriver Splitter, and the RF outputs go to the RF Driver Combiner.

The number of Drivers used is determined by the Driver Encoder board. All Drivers operate from +115VDC.

Drivers D1 through D7 are always turned on, D8 - D10 are frequency determined Drivers and D11 - D14 are AGC Drivers. By varying the number of Drivers turned on, the Driver Encoder regulates the RF drive to the 160 RF Amplifiers.

These 14 Driver RF Amplifiers are interchangeable with the Predriver and any of the 160 Big Step and Binary RF Amplifiers.

4.5.1.6 RF Driver Combiner

Each Driver RF Amplifier feeds its own ferrite toroidal combiner transformer primary and a copper rod passing through the fourteen toroids acts as secondary windings connected in series.

The combiner toroids adds RF voltages from the Drivers as the secondary passes from one transformer to the next. The RF voltage is low or zero at the ground point of the secondary rod and increases along the way to the RF Splitter.

4.5.1.7 Driver Tuning

The Driver Tuning Assembly provides variable inductive and capacitive tuning to resonate the combiner pipe.

4.5.1.8 Boost Transformer

Toroid transformer T1 provides a frequency determined boost/no boost step up action of the RF drive to the Drivers.

4.5.1.9 RF Drive Splitter A6 And RF Drive Cables

The purpose of the RF Splitter is to divide the combined output of the Driver Combiner and provide each Big Step and Binary RF Amplifier with the proper RF drive level.

The bottom end of the combiner rod bolts to the A6 board, which contains a large ferrite toroid transformer and conductive RF and ground planes.

There are 20 connectors, J1 through J20, which provide a total of 320 outputs, one for each half-quad on each of the 160 Big Step and Binary RF Amplifiers. Each connector provides connections for two sets of eight coaxial cables, the eight cables from each connector form a cable bundle which goes to the input connectors on Big Step and Binary Combiner Motherboards.

An additional connector J21 on the splitter assembly provides RF sample signals to other parts of the transmitter, as follows:

a. A synchronizing RF signal for the A/D Conversion process on the Driver Encoder.
b. An RF drive sample for Low Drive and High Drive Fault sensor circuits, and the Relative RF Drive metering also on the Driver Encoder.

4.5.2 Output Network Description

The Output Network transforms the impedance of the RF Combiner output, at about 8 Ohms, to 50 Ohms. This is done in two basic sections, the Bandpass Filter stage and the Output Matching stage.

The RF Output Network is contained in the Output Network cabinet, see VIEW 19, 25, 26, & 27.

NOTE - The Output Sample boards and ARC Detectors are detailed in Section H.

Refer to Figure 4-6, Output Network for the following description.

4.5.2.1 Bandpass Filter

The bandpass filter/output network is both a filter and an impedance matching network. The combiner output impedance is low (about 8 Ohms) and is matched or stepped up to 50 Ohms. The bandpass filter section of the Output Network consists of L1 and C1. L1 has switched amounts of inductance that is resonated with C1 at the selected frequency. C5 (in the output network cabinet) and C1 (5 9100 pF capacitors in parallel), C2, C3 and C49 are used to resonate out the inductance of the combiner pipe at the ground end. C2 and C3 are switched by relays K2 and K3. C49 is switched by relay K4.

K3 and K4 are turned on / off by Bit0 logic from the frequency control interface (1C1 Drive). K2 is controlled by Bit1 logic also from the frequency control interface.

The bandpass filter also smoothes the small steps that are present in the PA's output; the small steps result from sidebands outside the audio frequency range which are attenuated in the filter. Any other harmonic and spurious signals in the RF power amplifier section output are also attenuated by the bandpass filter.

4.5.2.2 π Matching Network

The π Matching Network consists of C2, L2, C3, and C4. L2 is a variable inductor that is varied by the LOAD Servo control. C2 and C4 are comprised of a combination of capacitors in parallel to form the input/output leg of the π network. C3 is adjusted to resonate with L2 at 3fc. The parallel resonant circuit provides further attenuation of the 3rd harmonic while passing the carrier frequency. A static drain choke and arc gap provide further protection at the RF Output connector.

4.5.2.3 RF Output Combiner RF Samples

A number of RF samples are picked up from various points in the RF Combiner and distributed to circuits elsewhere in the transmitter. (See VIEWS 15 & 19 for locations of the following).

T3 - Network Current Sample

At the ground point of the combiner, an RF current sample is picked up by a current transformer and compared to the RF voltage sample at the input of the Bandpass Filter. R5 is made up of 4 two watt resistors in parallel to provide a termination across T3 and to set the sample level.

T4 - Synthesizer Sync Sample

Ferrite inductor transformer T4 samples the current at the combiner output. The current sample goes to the Synthesizer Interface board.

C7 - Network Voltage Sample

At the input of the Bandpass Filter, an RF voltage sample is coupled by 3 capacitors and compared to the RF current sample at the ground end of the combiner pipe.

WARNING: Disconnect primary power prior to servicing.

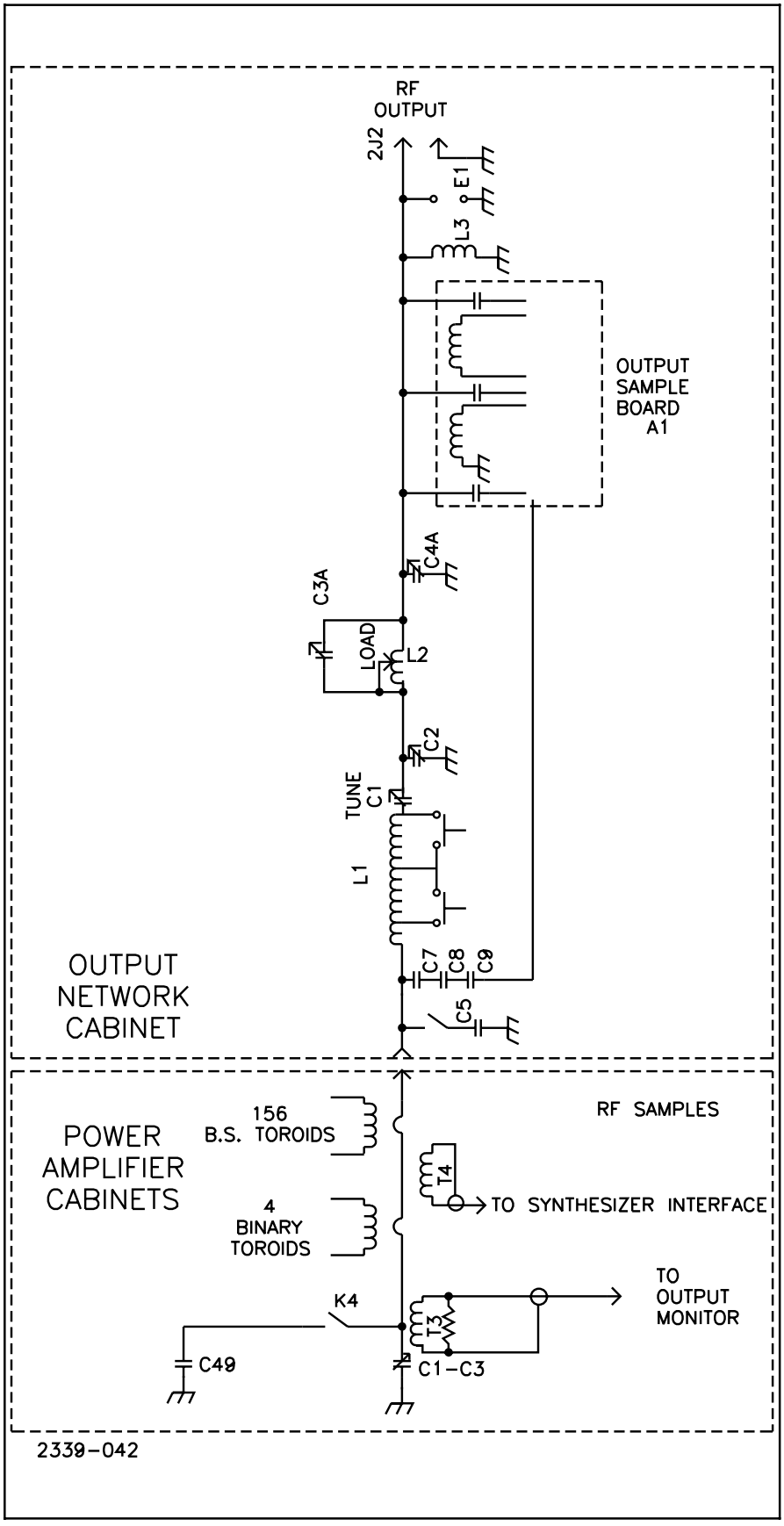

Figure 4-6. Output Network

4.6 Transmitter AC Power Circuits

NOTE: 230VAC is used in the following text for simplicity, however the Single Phase A\C MAINS can be from 198-251 VAC.

4.6.1 Single Phase AC Input

Refer To Figure 4-7 and VIEW 5 for the following discussion. Single phase 230VAC input is connected to contacts on the fuse block for F1 and F2 and is connected to Low Voltage Supplies Main breaker CB1. RV7 and RV8 protect the low voltage supplies from AC transients. These MOVs are connected to the single phase AC input through F1 and F2. Normally DS4 and DS5 on the Power Supply Status Panel are illuminated GREEN when 230 VAC is present and the protection is active. If an MOV should fail, F1 and/or F2 will open and DS4 and/or DS5 will not be illuminated GREEN.

When CB1 is set to the upper "ON" position, the high side of the single phase 230VAC is applied to the Controller Supply circuit breaker CB2, LV Supplies Enable circuit breaker CB3, K5 the Normal/Standby solid state relay, and Servo Supply breaker CB6.

4.6.1.1 Controller Supply

Refer to Figure 4-7 and see VIEW 7 for component location. When CB1, the Low Voltage Supplies Main breaker, is in the upper "ON" position, single phase 230VAC is applied to the Controller Supply circuit breaker CB2. If CB2 is in the upper "ON" position, single phase 230VAC is applied to T5. Multiple primary taps on T5 allow operation of the transformer from different input voltages. The secondary of T5 supplies 14 VAC to the AC connections on bridge rectifier CR46. The negative output of CR46 is grounded. The positive output is connected to filter capacitor C7 and bleeder resistor R7 and forms the +12VDC Controller Supply. This supply is also connected to the anode of K5 through R6. The purpose of this supply is to accommodate the Standby Mode of operation.

4.6.1.2 Normal/Standby Mode

Refer to Figure 4-7. When CB1, CB4, and CB2 are in the upper "ON" position and CB3 LV Supplies Enable is in the Standby position, the transmitter is in the "Sleep Mode." All low voltage supplies are turned off, except for the +12VDC Controller Supply. This active +12VDC supply will allow the controller to respond to a turn on command. When the transmitter is turned on from the front panel or from

WARNING: Disconnect primary power prior to servicing.

extended/remote control, a turn on signal from the Controller will be applied to relay K5. K5 contacts will close and allow single phase 230VAC to be applied to low voltage supply transformers T6 and T7. At this time, the low voltage supplies will be turned on and the transmitter will start the step start sequence and turn on. When the transmitter is shut OFF, the drive signal to K5 will be removed and the low voltage supplies will be turned off.

When CB3 LV Supplies Enable is in the Normal position, single phase 230VAC will be applied directly to T6 and T7 and the low voltage supplies will turn on and stay on whether the transmitter is on or off. The Normal mode should be used for initial turn on, frequency change, or troubleshooting.

4.6.1.3 Low Voltage Power Supply A

Refer to Simplified Low Voltage Power Supply diagram Figure 4-7, and/or Power Supply Schematic (843-5155-552). The Low Voltage Power Supply provides six different unregulated DC voltages +8VDC, - 8VDC, +12VDC, -12VDC, +22VDC and -22VDC. All transmitter logic and other circuits, except the Buffer, Predriver, and RF Power Amplifiers, operate from the Low Voltage supply.

Transformer T6 is a single phase transformer, with a tapped primary winding for operation from different input voltages. Circuit breaker CB4 protects the supply against overloads or shorts on the supply output. T6 has a secondary winding with taps to provide the different supply voltages.

The top winding provides 24 Volts AC to the AC input of bridge rectifier CR43. The negative output of CR43 is connected to filter capacitor C9, bleeder resistor R9, and is the -22VDC output. The positive output of CR43 is connected to filter capacitor C8 and bleeder resistor R8 and is the +22VDC output.

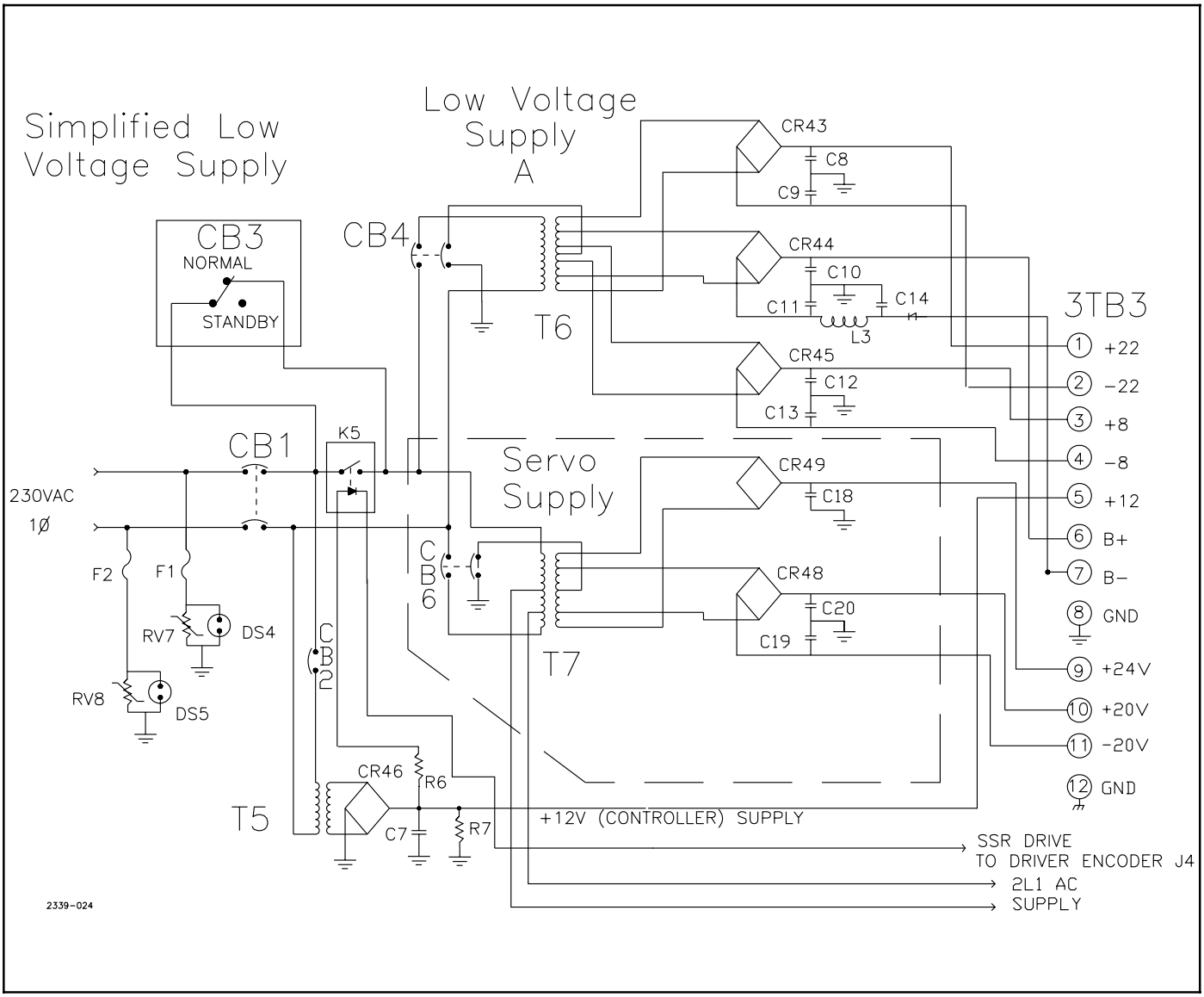

Figure 4-7. Simplified Low Voltage Supply

WARNING: Disconnect primary power prior to servicing.

The middle winding provides 12 Volts AC to the AC input of bridge rectifier CR44. The negative output of CR44 is connected to filter capacitor C11 and bleeder resistor R11. This supply is further filtered by L3 and C14. Bleeder resistor R38 is connected across C14. This forms the -12VDC or unregulated B- supply. The positive output of CR44 is connected to filter capacitor C8 and bleeder resistor R8. This supply is the +12VDC or unregulated B+ supply. Filter capacitor C210 and bleeder resistor R210 are installed to further filter the supply.

The lower winding provides 10 Volts AC to the AC input of bridge rectifier CR45. The negative output of CR45 is connected to filter capacitor C13 and bleeder resistor R13 and is the -8VDC output. The positive output of CR45 is connected to filter capacitor C12 and bleeder resistor R12 and is the +8VDC output.

4.6.1.4 Power Distribution Boards

The Power Distribution Board distributes + and -8V, + and -12V and + and -22V to other transmitter printed circuit boards. The only components on the Power Distribution board are seven connectors.

4.6.1.5 Servo Power Supply

The Servo Power Supply provides +24VDC, +20VDC, and -20VDC. All Servos and switching relays are operated from this supply.

Transformer T7 is a single phase transformer, with a tapped primary winding for operation from different input voltages. Circuit breaker CB6 protects the supply against overloads or shorts on the supply output. T7 has a secondary winding with taps to provide the different supply voltages.

The top winding provides AC to bridge rectifier CR49, which forms the +24VDC supply. The output is connected to filter capacitor C18 and bleeder resistor R39.

The middle winding provides AC to bridge rectifier CR48. The negative output is connected to filter capacitor C19 and bleeder resistor R41, and this forms the -20VDC supply.

The positive output is connected to filter capacitor C20 and bleeder resistor R39, and this forms the +20VDC.

4.6.1.6 2L1 Motor Switch Supply

Two sets of wires are connected across the primary taps of T7, that provide 110VAC for the 2L1 motors.

4.6.2 3 Phase AC Input

NOTE: 480V is used for simplicity, however the 3 Phase A\C MAINS input can be from 365-505VAC.

3 Phase AC input conductors are directly wired to the top set of contacts of K2 (SEE VIEW 5). RV1/RV2, RV3/RV4, and RV5/RV6 protect the RF Amplifier Power Supplies from AC transients. These MOV's are connected to the 3 phase AC input through F3, F4, and F5. Normally DS1, DS2, and DS3 on the Power Supply Control Panel are illuminated GREEN when 480 VAC is present and the protection is active. If the MOV's should fail after they have provided protection from a transient, F3, F4, and/or F5 will open and DS1, DS2, and/or DS3 will not be illuminated GREEN. AC line monitor K10 is connected to the 3 Phase AC input and monitors the line for "phase imbalance" and low line voltage. Should either of these conditions occur, the monitor status line at terminal 7 will go low and turn OFF the transmitter and display an RF AMP POWER SUPPLY A/C MAINS FAULT.

4.6.2.1 Step Start Sequence

Refer to Figure 4-8, Simplified RF Amplifier Power Supply Diagram and/or Schematic (843-5155-552), and VIEW 5 for component location. When the RF Amplifier Power Supply is first turned on, turn-on control logic on the Controller board energizes solid state relay K3. K3 in turn energizes K1, the Step Start relay, and 3 Phase ac power is supplied to transformers A1T1A and A2T1A through three low-resistance high wattage resistors R1, R2 and R3. The series resistance limits surge current as power supply capacitors charge. When K1 energizes, an auxiliary contact also closes and provides a +22 Volt "K1 has closed" logic signal to turn-on control logic on the Controller board.

After one second, the turn-on control logic energizes solid state relay K4 which then energizes contactor K2. Heavy contacts on K2 apply primary power directly to transformer A1T1A and A2T1A. An auxiliary contact on K2 provides a +22 Volt "K2 has closed" logic signal to the turn-on control logic. About half a second later, K3 opens and step-start contactor K1 is de-energized, completing the Step Start sequence.

4.6.2.2 RF Amp Power Supply

Refer to Figure 4-8, Simplified RF Amplifier Power Supply Diagram and/or (843-5155-552). RF AMP Power supply A and B are exactly the same except for component designators. For discussion purposes supply A will be covered.

4.6.2.3 RF Amplifier Power Supplies

The voltages generated by the RF Amplifier Power Supplies are:

a. +60VDC, for the Buffer Amplifier and the 1/8 and 1/16 step Binary amplifiers.
b. +115VDC, for the Predriver, RF Drivers D1-D14 and the Driver Supply Regulator.
c. +230VDC, for the PAN RF Amplifiers, and the control section of the Driver Supply Regulator.

Transformer T1A is a 3-phase, open frame power transformer. The multiple windings in the primary allow an input voltage range from 365 Vac to 505 Vac. Three sets of secondary windings provide the ac power for the +230VDC and +115 VDC rectifier assemblies.

The 12-phase, 230 Volt supply is derived from two of the secondaries wired in an extended delta configuration and operating in parallel. The 230 volt, 6-phase rectified outputs from CR1A through CR12A and CR1B through CR12B are combined through Interphase transformer A1T2. Each pair of rectifiers are fused separately by fuses F1 through F12. Capacitors C1 and C2 along with MOV's RV9 and RV10 provide filtering and protection for each rectifier assembly respectively.

The third secondary of T1A feeds the rectifier assembly of CR25 through CR30. The output from these rectifiers forms the +115 VDC. The rectifiers are fused by F13 through F15.

WARNING: Disconnect primary power prior to servicing.

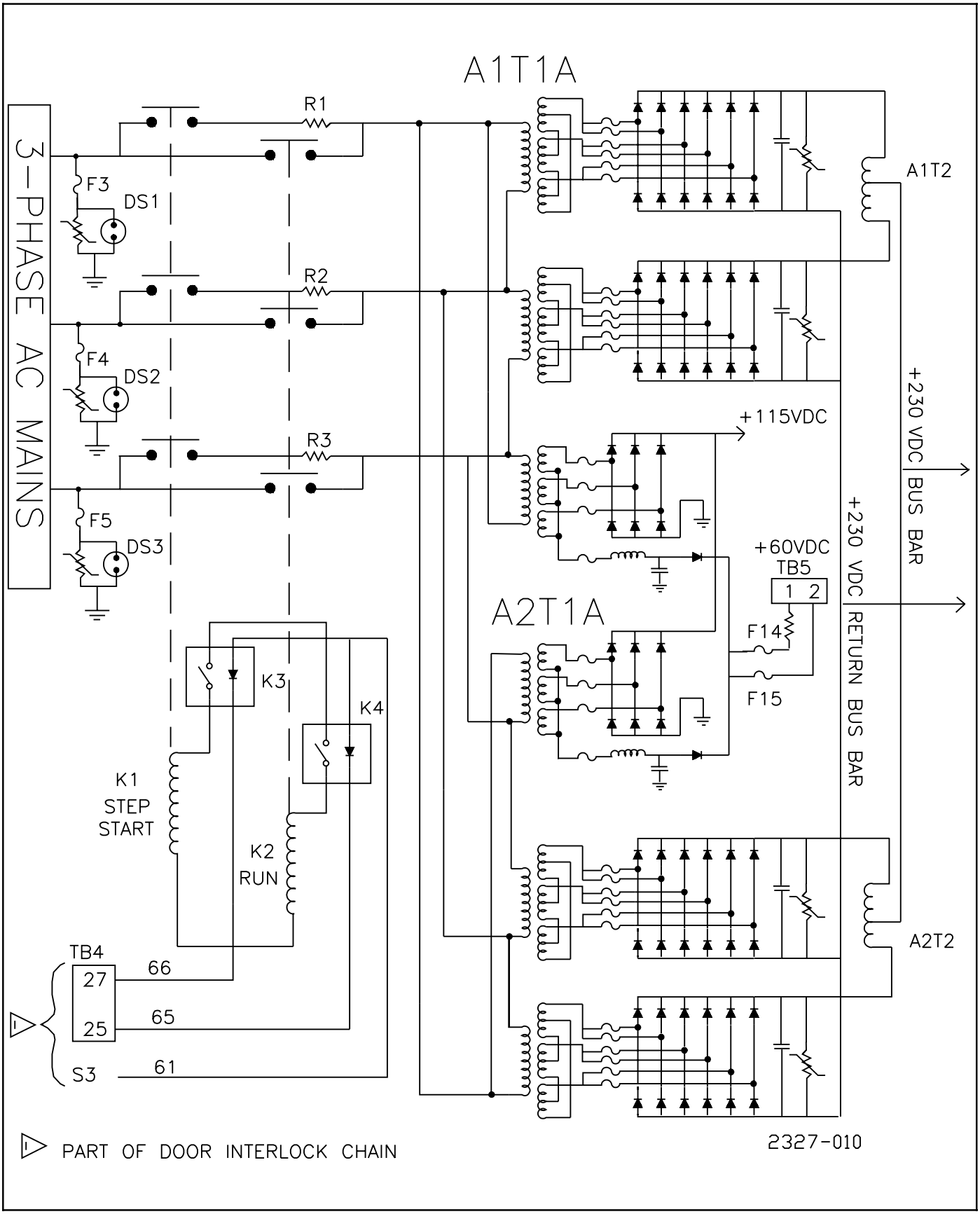

Figure 4-8. Simplified RF Amp Power Supply

WARNING: Disconnect primary power prior to servicing.

The neutral of this WYE configuration is brought out to provide 60 VDC. L1 and C5 provide additional filtering for 150-180 Hz ripple.

4.6.2.4 +230VDC Power Supply Crowbar Discharge Circuit

This circuit is comprised of four power MOSFETs operating in parallel to discharge the +230VDC and +115VDC supply anytime K1 and K2 are de-energized. Q1, Q2, Q3, and Q4 function as switches which will be open when the supply is energized. When K1 or K2 de-energize, a control voltage is applied to each gate to activate the MOSFETs. This control voltage comes from the 230VDC supply bus and is routed through R34 and "Normally Closed" auxiliary contacts on K1 and K2 to the individual gate circuits. Therefore the discharge path is self contained, i.e. no additional supply is needed to activate the circuit. R25, R26, R27, and R28 are in series with each MOSFET for current limiting. Each MOSFET has a zener diode across the gate to source to limit the gate voltage to 10V. The 115VDC supply will discharge through CR47 when the Crowbar activates.

4.6.2.5 +230VDC Supply Current Meter

The negative side of the A and B rectifier assemblies are tied together on one end of the +230VDC power supply current meter shunt SH1. The total +230 VDC supply current returns to ground at this point.

Meter shunt SH1 is located in lower rear section of the right PA compartment. The Supply Current meter (M2) is located on the center PA compartment front door, and is connected across the shunt.

The voltage across the shunt, which is proportional to supply current, also goes to the supply current overload circuit on the Analog Input board, through the switch board/meter panel. The current overload circuit provides a remote supply current metering output as well.

4.6.2.6 Blower Supplies

The 13 blowers operate from 3 Phase 480VAC and obtain their supply from F11, F12, and F13 which are connected to the primary of A1T1A. Two of the three phases are directly connected to each blower, while the third phase passes through blower current monitors K6 through K9. K6 monitors the Left Compartment, K7 the Center Compartment, K8 the Right Compartment, and K9 monitors both the Output Cabinet and the Power Supply Cabinet. Normally when the transmitter is operating and the blowers are functioning properly, DS6, DS7, DS8, and DS9 will be illuminated GREEN on the Power Supply status panel. Should a blower failure occur, the drop in blower current will be sensed and the transmitter will foldback to a safe operating level. (See VIEW 1 for component locations).

WARNING: Disconnect primary power prior to servicing.

4.7 Drive Multimeter

4.7.1 Introduction

This section describes the Drive Multimeter board.

The Drive Multimeter provides metering of the Predriver and RF Driver sections of the transmitter. A probe, with four meter positions, is also provided for AC and DC voltage measurements on printed circuit boards in the transmitter's non-interlocked compartment.

4.7.2 Location

The Drive Multimeter is located on the back side of the right PA compartment front door. (See Fig. 4-9).

4.7.3 Principles of Operation

The meter has a 100 microampere movement, and two scales, 0-3 and 0-10. The meter switch positions are labeled with the name of the metered function and the scale used. For some positions, a X10 or X100 multiplier is applied to the meter scale reading.

Refer to the Drive Multimeter schematic diagram for the following circuit discussion. Meter M1 is protected against excessive voltages and currents by 1-Amp rectifier diodes CR4 and CR5. Capacitor C3 provides an RF bypass around the meter movement.

4.7.3.1 Metering Driver Section Parameters

For 0-3 Volt, 0-30 Volt, and 0-300 Volt DC ranges, the multimeter is a 10,000 Ohms per Volt meter. For current ranges, the meter acts as a voltmeter, measuring the voltage drop across a resistor in the DC current path. One side of the meter is grounded through a section of switch S1 for driver section voltage measurements. The meter is isolated from ground for current measurements.

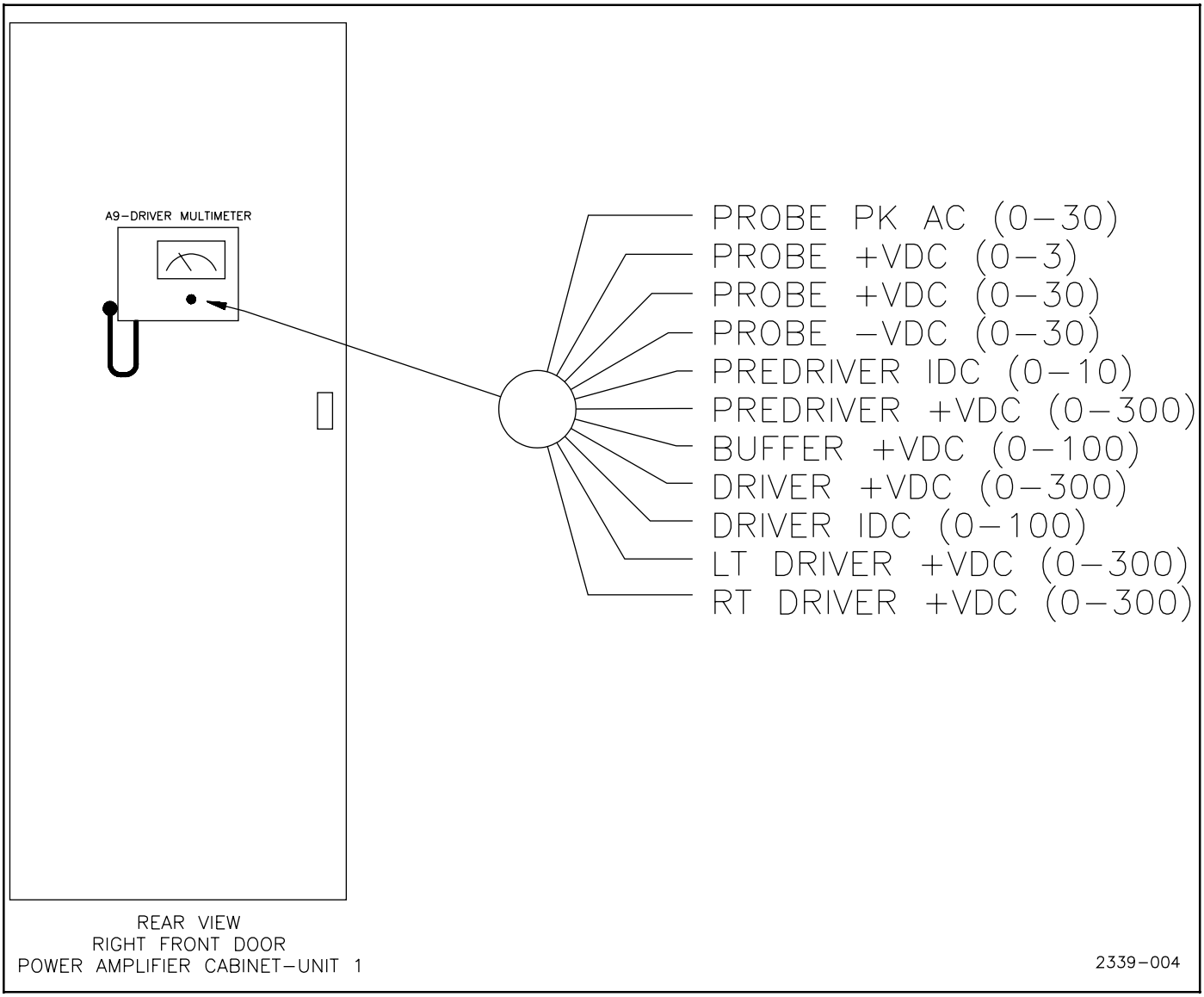

Figure 4-9. Driver Multimeter Switch Location and Positions

WARNING: Disconnect primary power prior to servicing.

The Drive Multimeter positions are defined and detailed in the Sections where the meter resistors are located.

4.7.4 Multimeter Probe

The multimeter uses a flexible coiled patch cord with a clip-on probe for convenient measurement of voltages in the non-interlocked compartment. Measurement ranges available are 0 to 30 VAC Peak, 0 to +3 VDC, 0 to +30 VDC, and 0 to -30 VDC.

Resistor R5, 29.4K 1%, is the multiplier resistor for the 0-3 Volt range. The total 30K resistance required for this range includes the meter resistance.

Resistor R3, a 301K 1% resistor, is the multiplier resistor for the 0-30 Volt range. Positive and negative voltage ranges are obtained by grounding either the negative or positive meter terminal through S1.

For AC Voltage measurements, CR1, R4, C1 and R1 make up a peak detector. Resistor R2 is the multiplier resistor for the ac voltage range.

4.7.5 Maintenance

There are no maintenance adjustments on the Drive Multimeter board.

4.7.6 Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Check connectors to be certain they are properly and firmly inserted. Check ribbon cables for possible damage, such as crimping.

Visually check S1. Liquid or spray contact cleaners should be used with caution; don't use any cleaner that could leave a residue that might collect dirt and dust.

Use an accurate digital multimeter to measure resistances. It may be necessary to remove plug-in modules or other connectors to eliminate parallel resistance paths that could affect the measurement.

CAUTION

When measuring resistances in any metering circuit, change the multimeter position to some OTHER range. Ohmmeters could provide enough current to damage the sensitive meter movement.

When checking the meter, remove all power from the transmitter and disconnect P4 and P5 from the multimeter board to eliminate any possible parallel current paths. Use a battery or low-voltage DC power supply and current limiting resistor to provide a low current (50 to 100 microamperes) through the meter movement, with a low-current meter of known accuracy in series with M1.

4.8 Control Multimeter

4.8.1 Introduction

This section describes only the inputs to the Control Multimeter. Since the Control Multimeter is exactly the same as the Drive Multimeter except for the inputs to the meter, please refer to the Drive Multimeter section for a more detailed description of the actual meter circuits.

4.8.2 Location

The Control Multimeter is mounted in the center PA compartment on the upper right hand side (See Fig. 4-10).

4.8.3 Control Multimeter Inputs

Refer to the Control Multimeter schematic diagram for the following circuit discussion.

The Control Multimeter has eight (8) inputs as follows:

1. A/D Input
2. B+/B- Unregulated
3. +12 VDC
4. A/D Output
5. B- Drive
6. +22/-22(+) and +22/-22(-)
7. +8/-8 VDC
8. Probe Input

With the exception of the A/D input and A/D output positions, the Control Multimeter is used to monitor the Low Voltage Supplies to the circuit boards. For more information on the purpose of these monitor points refer to Section K, A/D Converter board.

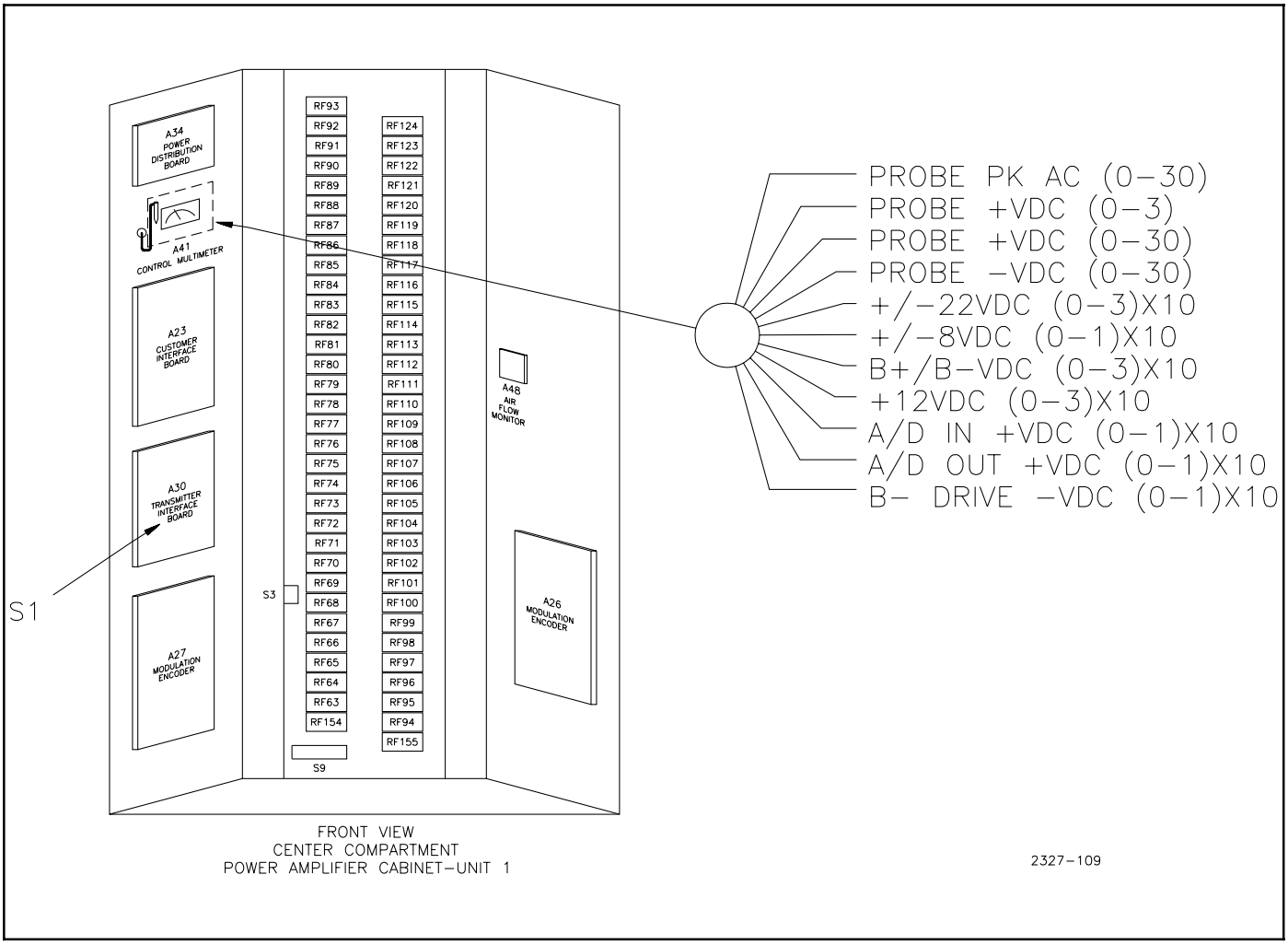
A34 POWER DISTRIBUTION BOARD
A41 CONTROL MULTIMETER
A23 CUSTOMER INTERFACE BOARD
A30 TRANSMITTER INTERFACE BOARD
A27 MODULATION ENCODER
A48 AIR FLOW MONITOR
A26 MODULATION ENCODER
S1
S3
S9
RF93 RF92 RF91 RF90 RF89 RF88 RF87 RF86 RF85 RF84 RF83 RF82 RF81 RF80 RF79 RF78 RF77 RF76 RF75 RF74 RF73 RF72 RF71 RF70 RF69 RF68 RF67 RF66 RF65 RF64 RF63 RF154
RF124 RF123 RF122 RF121 RF120 RF119 RF118 RF117 RF116 RF115 RF114 RF113 RF112 RF111 RF110 RF109 RF108 RF107 RF106 RF105 RF104 RF103 RF102 RF101 RF100 RF99 RF98 RF97 RF96 RF95 RF94 RF155
PROBE PK AC (0−30)
PROBE +VDC (0−3)
PROBE +VDC (0−30)
PROBE −VDC (0−30)
+/−22VDC (0−3)X10
+/−8VDC (0−1)X10
B+/B−VDC (0−3)X10
+12VDC (0−3)X10
A/D IN +VDC (0−1)X10
A/D OUT +VDC (0−1)X10
B− DRIVE −VDC (0−1)X10
FRONT VIEW
CENTER COMPARTMENT
POWER AMPLIFIER CABINET−UNIT 1
2327−109

Figure 4-10. Control Multimeter Location and Positions

WARNING: Disconnect primary power prior to servicing.

5.1 Introduction

This Section provides transmitter frequency change procedure and general system preventative maintenance information.

5.2 Frequency Change Procedures

If a complete frequency change is desired this procedure can be followed in order. To allow a faster frequency change, procedures which are performed to achieve optimum transmitter performance will be covered last.

NOTE

The following procedure assumes the transmitter is operating in the Normal Operation mode at 100 kW with no faults.

5.2.1 Frequency Change

a. Select the new frequency of operation on the Frequency Select switches.

b. The transmitter should shut OFF.

c. Using the Transmitter Band Chart and note the 2C1 & 2L2 Volts for the new frequency.

d. Verify the TUNE meter indicates the same as the new 2L2 number.

e. Verify the LOAD meter indicates the same as the new 2C1 number.

f. Verify the NORMAL LED is illuminated on the front panel of the Frequency Control board.

5.2.2 Low Power

a. Press the LOW power switch on the front panel. The Power meter selector switch should be in FWD.

b. Begin raising the RF forward power by slowly turning R66 clock- wise.

c. Stop increasing power when Forward power is 10 kilowatts.

d. Using the front panel meters, verify the following conditions:

1. PA +VDC = 240 to 250 volts.
2. PA Current = 60 to 80 amps.
3. Number of RF Amplifiers (steps) ON should be 21 to 23 (Open the left front door and count the number of illuminated green LED's on the RF Amplifiers along the left side of the compartment starting at the bottom and counting upward).

If an Antenna VSWR overload occurs before 10 kW is reached, skip to the Antenna Null adjustment following this section and return here when completed.

e. Do an RF Amp temperature test by moving your hand about 1 inch (2.54 cm) in front of the RF Amp doors to feel the air temperature. It should only be slightly warm. The left PA compartment temperature will be slightly warmer than the other compartments. This is normal since these are the RF Amps being turned on.

f. Check the 10 kW meter readings with the readings on the Factory Test Data Sheets under PA Voltage, PA Current, and Number Of Steps On. If all are within 10%, continue with the next step.

5.2.3 High Power

a. Depress the High Power switch on the front panel.

b. Adjust R65 clockwise until 100 kW is reached.

c. Using the front panel meters, verify the following conditions:

1. PA +VDC = 225 to 235 volts.
2. PA Current = 460 to 470 amps.
3. Number of RF Amps ON = 64 to 66 (Open the left front door and count the number of illuminated green LED's on the RF Amplifiers along the left side of the compartment starting at the bottom and counting upward).

d. Do an RF Amp temperature test by moving your hand about 1 inch in front of the RF Amp doors to feel the air temperature flowing over the RF AMPS.

5.2.4 Antenna VSWR Null

If an Antenna VSWR overload occurs before 100 kW is reached, note the Antenna Null position on the front panel multimeter. Refer to the ANT/NET NULL setup in Section **???**

Additionally, "Fine Tuning" of the VSWR Null may be accomplished by using the Phase and Amplitude adjustments of the Output Monitor Board for each frequency.

5.2.5 Completion Of Basic Frequency Change

This completes all the basic requirements in changing the frequency of the transmitter. Use the provided forms at the end of the Controls And Indicators Section IIIA to log all meter readings for future reference.

5.3 Maintenance

5.3.1 Maintenance and Daily Records

It is strongly recommended that a station keep separate logbooks for daily operation and for maintenance. The daily logbook should consist of routine meter readings and note any discrepancies that are found during normal operation. The maintenance logbook should contain more detailed information concerning external meter voltage readings taken from boards and components, any action taken during the routine maintenance period, and a record of repairs and observations made during maintenance.

WARNING: Disconnect primary power prior to servicing.

5.4 Preventive Maintenance

Preventive maintenance should mainly consist of three operations: inspecting, cleaning, and tightening.

5.4.1 Inspecting

This is a visual and physical inspection of the transmitter looking for loose connections, signs of corrosion and dirt, broken or overheated components and wear on moving parts.

5.4.2 Cleaning

This is the stage in which the dirt and/or corrosion is removed from the transmitter and the air filters are cleaned and/or replaced. The transmitter should be cleaned using an approved solvent and/or vacuum or compressed air device. The air system should be checked and the filters cleaned or replaced as needed.

5.4.3 Tightening

This is the stage when the loose component connections discovered during inspection and cleaning are tightened. Areas to pay particular attention to are high current points, high power compartments and moving parts such as fans and tuning controls. Caution should be taken not to overtighten a connection as this may damage the connection.

WARNING: Disconnect primary power prior to servicing.

6.1 Introduction

This section of the technical manual will contain troubleshooting procedures for the transmitter.

This troubleshooting section is divided as follows:

a. Troubleshooting Control Front Panel Indicators (Page 6-1)
b. Troubleshooting Frequency Control Front Panel Indicators (Page 6-13)
c. Troubleshooting Power Supply Status Panel Faults (Page 6-18)
d. System Faults With No Front Panel Indication (Page 6-19)
e. Troubleshooting Low Voltage Power Supplies (Page 6-20)
f. Measuring RF Amplifier Drive/Drain Amplitude And Phase (Page 6-22)

This section is a troubleshooting guide for the transmitter as a system. The purpose of this section is to isolate the problem to a board or circuit then the troubleshooting for that board will be covered in the section of the manual for that particular board.

6.2 Making Safe Measurements

This equipment to be opened, operated, and maintained by authorized personnel only.

Never work when alone or tired.

Read safety warning and first aid information in the front of this manual before proceeding.

After the transmitter has been turned off, verify that the RF AMP Power Supply is discharged by checking "PA+VDC" on the front panel multimeter.

Use breakers or disconnect switches to remove all primary power to transmitter and peripheral equipment before opening enclosures, or removing any panel or shield.

Do not rely on internal contactors, relays, interlock, or switching devices to remove all dangerous voltages.

Use a volt-meter to verify the power supplies have been discharged prior to touching any components.

If a voltage reading or waveform analysis is required, route test leads through an opening in the cabinet to the desired measurement point. Secure leads away from any circuit with voltages beyond the break down point of their insulation or the insulation rating of the measurement device.

Do not hold the measuring device in your hand while the equipment is energized. Securely ground the chassis of any scope, analyzer, or other test equipment.

Do not operate with doors, shields or panels removed.

After taking reading, use breakers or disconnect switches to again remove all primary power to transmitter and peripheral equipment before opening enclosure where test leads were routed or connected. Verify the discharge of all high voltage points and points where test leads are attached before touching any points or removing test leads.

6.3 Troubleshooting Control Front Panel Indicators Faults

The following is a list of all the transmitter faults that appear on the Control front panel of the transmitter.

RF Flow Indicators	
FRQUENCY SYNTHESIZER	Page 6-2
BUFFER AMP	Page 6-2
PREDRIVER	Page 6-3
DRIVER	
HIGH DRIVE	Page 6-4
LOW DRIVE	Page 6-3
RF AMP	
FUSE	Page 6-5
TEMP	Page 6-5
OUTPUT MONITOR	
NETWORK VSWR	Page 6-6
ANTENNA VSWR	Page 6-7
VSWR TEST	Page 6-7
SUPPLY FAULT	Page 6-8
Digital Audio Flow Indicators	
ANALOG INPUT	
POWER FOLDBACK	Page 6-8
SUPPLY FAULT	Page 6-8
A/D CONVERTER	
CONVERSION ERROR	Page 6-8
SUPPLY FAULT	Page 6-8
ENCODERS	
MODULE/CABLE INTERLOCK	Page 6-8
SUPPLY FAULT	Page 6-9
Control and Power Supply Indicators	
CONTROLLER	
RF MUTE	Page 6-12
SUPPLY FAULT	Page 6-12
RF AMP POWER SUPPLY	
A/C MAINS FAULT	Page 6-10
CURRENT FAULT	Page 6-10
VOLTAGE FAULT	Page 6-11
TEMP FAULT	Page 6-11
AIR FLOW	
REDUCED	Page 6-12
FAULT	Page 6-13
INTERLOCKS	
DOOR	Page 6-11
EXTERNAL	Page 6-12

WARNING: Disconnect primary power prior to servicing.

6.4 Troubleshooting Faults In The RF Chain

If a fault occurs somewhere in the RF chain, all stages after the faulty stage will also indicate a fault. If the fault sensing circuitry has failed, the transmitter will still be on, with an RF Mute applied. Begin troubleshooting at the first stage of an indicated fault.

6.4.1 Frequency Synthesizer/Buffer Amplifier/Predriver/Low Drive

If these Control front panel LEDs are all illuminated RED, this would indicate that the drive from the Synthesizer Interface output is low.

6.4.1.1 Selecting Synthesizer Interface B

If the transmitter is equipped with optional Synthesizer Interface B:

a. Select B by moving S2, on the RF Interface, to the B position or providing the correct remote control input.

b. Turn the transmitter on again. If the transmitter operates normally the fault is on Synthesizer Interface A.

NOTE

The transmitter can be operated normally using Synthesizer Interface B, until time can be scheduled to continue troubleshooting Synthesizer Interface A.

c. If the fault is still present, switch back to Synthesizer Interface A and continue.

6.4.1.2 Synthesizer Interface "A" Troubleshooting:

a. Check for +22VDC on F1, -22VDC on F2, and +8VDC on F3 on Synthesizer Interface A. If present, then continue. If not present, troubleshoot the Low Voltage supplies.

b. With an oscilloscope, monitor TP5 RF OUT on the RF Interface board. Verify that S2 is in the A position.

1. If no RF is present, move the oscilloscope to J4-8 on Synthesizer Interface A. A 4 to 5 Volt squarewave at carrier frequency should be present.
2. If the waveform is not correct, troubleshoot the Synthesizer Interface by turning to the Troubleshooting section for the Synthesizer Interface.

6.4.2 Buffer Amplifier/Predriver/Low Drive

If these Control front panel LEDs are illuminated RED, this indicates that the Buffer Amplifier output RF drive to the Predriver is low.

6.4.2.1 Select Buffer Amplifier B

The transmitter is equipped with two Buffer Amplifiers. To select B:

a. Move S1, Predriver Select Switch, on the Driver Encoder to the B position or provide the correct control input. (Note that the Buffer and Predriver switch together).

b. Turn the transmitter on again, and observe the Control front panel.

6.4.2.2 Defective Buffer Amplifier A

a. If the transmitter returns with no fault, refer to the Troubleshooting section for the Buffer Amplifier.

NOTE

The transmitter can be operated normally with Buffer Amplifier B, until time can be scheduled to continue troubleshooting Buffer Amplifier A.

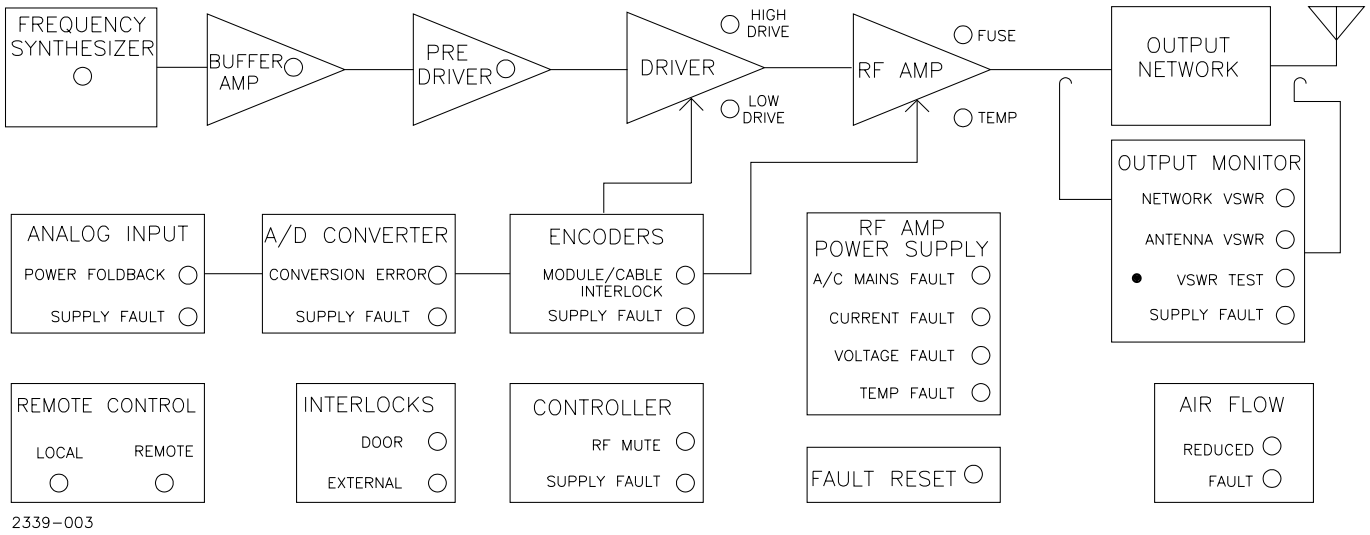

Figure 6-1. Control Front Panel

WARNING: Disconnect primary power prior to servicing.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Check for open fuses on the Buffer Amplifier. If open fuses are found, replace and troubleshoot the Buffer Amplifier.

6.4.2.3 No Buffer Amplifier Power Supply

a. Use the Driver Multimeter to measure the Buffer Voltage during the step-start sequence. During step-start there should be a +20-45VDC signal.
   1. If the supply is not present, troubleshoot the +60VDC power supply.

6.4.2.4 No Buffer Amplifier RF Input

a. With an oscilloscope, determine that the waveform on TP5 of the RF Interface board is present and at the correct frequency.
b. With an oscilloscope, look at the input to the Buffer Amplifier on the ungrounded end of R16.
   1. The level should measure 4-4.5Vpp.
   2. If not refer to the overall diagram to troubleshoot the circuit back to the RF Interface board.

6.4.3 Predriver/Low Drive

If these Control front panel LEDs are illuminated RED,it would indicate that the RF drive level to the Driver stage is low.

6.4.3.1 Select Predriver B

The transmitter is equipped with two Predrivers. To select B:

a. Move S1, Predriver Select Switch, on the Driver Encoder to the B position or provide the correct control input. (Note that the Buffer and Predriver switch together).
b. Turn the transmitter on again, and observe the Control front panel.

6.4.3.2 Defective Predriver A

a. If the transmitter returns with no fault, refer to the Troubleshooting section for the RF Amplifier.

NOTE

The transmitter can be operated normally with Predriver B, until time can be scheduled to continue troubleshooting Predriver A.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

NOTE

The power supply for the Predrivers is fused on the Buffer Amplifier. F1 supplies Predriver A and F2 supplies Predriver B.

b. Check for open Predriver supply fuses on the Buffer Amplifier. If open fuses are found, replace the fuses and troubleshoot the Predriver.

6.4.3.3 No Predriver Power Supply

a. Use the Driver Multimeter to measure the Predriver Voltage during the step-start sequence. During step-start there should be a +90-115VDC signal.
b. If the supply is not present, troubleshoot the +115VDC power supply.

6.4.3.4 Observe DS3

a. If DS3 on the Predriver is not illuminated GREEN during the step-start sequence:

6.4.3.5 No Predriver RF Input

NOTE

Refer to "Measuring RF Drive" at the end of this section for the following discussion.

a. With an oscilloscope, determine that the RF drive waveform on the Predriver is present and at the correct frequency.
   1. If there is little or no RF drive, refer to the overall diagram to troubleshoot the circuit back to the Buffer Amplifier.

6.4.3.6 Loss of Turn-On Command

a. Measure J1-5 on the Driver Encoder, this point should be at least -2VDC.
   1. If it is not, refer to the Troubleshooting portion for the Driver Encoder.
b. If the voltage is correct, use the overall wiring diagram and the Driver Combiner schematic to check continuity up to the Predriver input.

6.4.3.7 Failed Predriver Tuning Components

It is possible for one of the components on the Predriver Tuning board to have failed and therefore de-tune the output. Failed components like capacitors and inductors can sometimes be identified by checking for abnormal heating after operating for a short time. Refer to the Predriver Tuning board to test the relay switching circuits and to the Frequency Control Interface board to determine if the correct bandswitched outputs exist. If the setting of the Predriver Tuning coil L1 has been adjusted, it can be retuned for maximum Predriver Current on the Drive multimeter when operating at 1600 kHz.

6.4.4 Low Drive

Low Drive Control front panel LED is illuminated RED.

This would alert you that the RF drive to the RF Amplifiers is not sufficient.

The transmitter is equipped with AGC circuits on the Driver Encoder, such that if Driver Amplifiers fail others will take their place and RF drive level will be maintained. However, if too many Drivers have failed it may not be possible for the Driver Encoder to keep the RF drive level within the lower limit.

6.4.4.1 Loss of Driver Amplifiers

a. Turn the transmitter on, and observe DS1 and DS2 on all Driver Amplifiers.

1. If any of these indicators turn RED during the step-start sequence the Driver Amplifier side associated with the indicator will need to be repaired. Refer to the Troubleshooting section for the RF Amplifier.

Note

If Driver amplifiers have failed, it may be possible to return to normal operation without repairing the RF Amplifiers immediately. Refer to Section 6A, Emergency Operating Procedures, Paragraph Title: Driver Amplifier Failure.

6.4.4.2 Loss of 115VDC Supply.

a. Separately select LEFT and RIGHT DRIVER +VDC positions on the Driver Multimeter and turn on the transmitter.

1. If the meter does not deflect upscale, troubleshoot the +115VDC power supply.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If the supply is ok, check fuses F1 and F2 in the rear of the Driver Compartment.

c. If the fuse(s) check ok, test for continuity from the F1 and F2 clips to the respective fuse clips on the Driver Amplifiers.

d. If either fuse is open, measure the resistance from the fuse clip to ground.

e. If a short is found, pull all of the Driver Amplifiers and recheck.

f. If still shorted, suspect a filter capacitor.

6.4.4.3 Observe DS3 on All Driver Amplifiers

a. If DS3 on the Driver Amplifier(s) is not illuminated GREEN during the step-start sequence:

6.4.4.4 No Driver Amplifier(s) RF Input

NOTE

Refer to "Measuring RF Drive" at the end of this section for the following discussion.

a. With an oscilloscope, determine that the RF drive waveform on all Driver Amplifiers is present and at the correct frequency.

1. If there is little or no RF drive, refer to the overall diagram to troubleshoot the circuit back to the Predriver Tuning circuits.

6.4.4.5 Loss of Turn-On Command

a. Check the Driver Amplifier turn-on signals on the Driver Encoder board at J1-1, 3, 11, 13, 15, and J2-1. Each point should be approximately -2VDC.

b. Check the Driver Amplifier turn-on signals on the Driver Encoder board at J2-11, 13, and 15.

NOTE

Driver Amplifiers D8 through D10 are frequency determined. Refer to the Detailed Circuit Description in the Driver Encoder section to determine if these Driver Amplifiers should be turned on.

c. Check the Driver Amplifier turn-on signals on the Driver Encoder board at J2-1, 3, 5, and 7.

1. Only D11 and D12 should be turned on during the step-start sequence.

d. If these outputs are not correct, refer to the Troubleshooting section for the Driver Encoder.

e. If the voltage is correct, use the overall wiring diagram and the Driver Combiner schematic to check continuity up to the Driver Amplifier inputs.

Note

If Driver Encoder outputs are not correct, it may be possible to return to normal operation. Refer to Section 6A, Emergency Operating Procedures, Paragraph Title: Driver Encoder Bypassing.

6.4.4.6 Failed Driver Tuning Components

It is possible for one of the components in the Driver Tuning board to have failed and therefore de-tune the output. Failed components like capacitors and inductors can sometimes be identified by checking for abnormal heating after operating for a short time. Test the relay switching circuits and refer to the Frequency Control Interface board to determine if the correct bandswitched outputs exist.

6.4.4.7 Fault Sensing

a. If the above checks do not reveal the source of the problem, it is possible that the RF drive level sensing circuit has failed. Refer to the Troubleshooting section of the Driver Encoder, to determine the fault.

6.4.5 High Drive

If the transmitter has turned itself off, and the HIGH DRIVE Control panel LED is illuminated RED, the RF drive level to the RF Amplifiers is over the upper limit. If there is too much drive:

6.4.5.1 Too Many Drivers Turned On

a. Turn on the transmitter and observe DS3 on each Driver that is not normally operational at the current frequency.

b. If DS3 turns GREEN during the step-start sequence, monitor the turn-on lines at J2 on the Driver Encoder for the Drivers that are turned on but should not be in service.

c. If during the step-start sequence, any of these lines go to -2VDC refer to the Troubleshooting section of the Driver Encoder.

d. If the turn-on signals for these Drivers does not go to -2VDC, but DS3 is illuminated GREEN during the step-start sequence, troubleshoot the turn-on/turn-off circuits

WARNING: Disconnect primary power prior to servicing.

on those Drivers. Refer to the Troubleshooting section of the RF Amplifier.

6.4.5.2 Fault Sensing

a. If the above checks do not reveal the source of the problem, it is possible that the RF drive level sensing circuit has failed. Refer to the Troubleshooting section of the Driver Encoder, to determine the fault.

6.4.6 RF Amp Temp

If the transmitter is operating at reduced power or has shut itself off, and the RF AMP TEMP/ANALOG INPUT POWER FOLDBACK Control front panel LEDs are illuminated RED, then the temperature of RF1 or the ambient air has exceeded 70 degrees C. The amount of power reduction depends upon how long the transmitter has been operating in the overtemperature condition. A prolonged over-temperature condition will eventually turn the transmitter off.

a. Measure the intake air for the left PA cabinet, if it is greater than 50 degrees C then additional cooling will be required for the transmitter facility.
b. Check the intake air filters of the transmitter. A plugged or dirty filter can cause a lack of proper airflow and excessive heat in the PA compartments. Replace as needed.
c. Verify that the exhaust is not restricted. Correct as needed.
d. Check the tuning of the transmitter. Mistuning of the transmitter can cause the RF Amplifiers to run less efficiently therefore generating more heat.
e. If the intake air temperature is less than 50 degrees C, the filters are clean and the exhaust is unrestricted, it is possible that RF1 is defective.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. Turn off the transmitter and open the left cabinet inner front door.
2. Remove RF1 and feel the heatsink. If it is extremely hot compared to the other RF Amplifier heatsinks, troubleshoot the amplifier using the Troubleshooting portion of Section G, RF Amplifier.

f. If the amplifier is not hot, it is possible that the temperature detector circuit, or the temperature sensor and cable assembly is defective.
   1. Turn on the transmitter, and monitor TP3 on the Modulation Encoder A29 with a voltmeter.
   2. If voltage at TP33 is less than the voltage at U37-8 or U37-6, refer to the Troubleshooting portion of Section L, Modulation Encoder to determine the cause.

6.4.7 RF Amp Fuse

If the transmitter is operating at reduced power and/or the RF AMP FUSE Control front panel LED is illuminated RED, then:

a. One or more fuses (230VDC or RF Drive) on one or more RF Amplifiers is open.
b. RF drive on one or more RF Amplifiers is low, or
c. One or more 230VDC fuses on a Fuse Board is open or any combination of the above.

Note

The fuse detector circuit has no function other than to illuminate the LED.

To determine which RF Amplifier(s) has an open fuse(s):

a. Open the left, center, and right front doors and observe each of the five Modulation Encoders.
b. If any of these Modulation Encoders has DS6 illuminated RED, then an RF Amplifier(s) connected to that Modulation Encoder has an open fuse(s).

   For example:
   Suppose that DS6 is illuminated RED on Modulation Encoder A29, then any RF Amplifier, RF1 through RF31 and RF152, could have an open fuse(s). We will be using this example for the rest of the discussion, it applies to all other Modulation Encoders. Which type fuse(s) is open depends upon the symptoms or other indicators.
c. Turn on the transmitter and observe DS1 and DS2 on RF Amplifiers RF1 through RF31 and RF152, if any of these indicators is illuminated RED, then the +230VDC fuse associated with that RF Amplifier is open. To repair the module refer to the Troubleshooting portion of Section G, RF Amplifiers.
d. If DS1 and DS2 are not illuminated RED on RF Amplifiers RF1 through RF31 and RF152, then use the Control Multimeter Probe on the PROBE +VDC (0-30) scale and measure the voltages on TP2, TP16, TP17, and TP18 on the A29 Modulation Encoder. Normally these test points should measure 12.5VDC. If one measures 7.5VDC or less then check all of the fuses for that group of eight RF Amplifiers.

   For example:
   If TP2 measures 7.5VDC, then ohmmeter check all of the fuses (+230VDC and RF) on RF Amplifiers RF24 through RF31. If an open fuse(s) is found troubleshoot the module(s) referring to the Troubleshooting portion of Section G, RF Amplifier. If needed refer to the overall wiring diagram and the Modulation Encoder section to determine which groups of eight RF Amplifiers are connected to each fuse detector.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

e. If no open fuse(s) were found on the RF Amplifiers, open the left PA cabinet rear door and ohmmeter test all of the 35A fuses on the Fuse Boards A39 and A40 for the above example.

f. If an open fuse(s) is found, replace it with the proper size and ohmmeter test the fuse clip to ground. This will also test the filter capacitors associated with that fuse. A shorted capacitor will open the 35A fuse each time the +230VDC supply is present.

g. If no open 35A fuses were found, check for RF Drive on both sides of all eight RF Amplifiers. Refer to paragraph entitled "Measuring RF Drive Level" in this section.

h. If drive is low or not present, ohmmeter check the drive fuses F3 and F4 on the modules.

i. If no open fuses are found, use the Drive Cable Interconnect Diagram, 843-5155-161, to determine which cables connect the modules to the RF Splitter, A6. Use an ohmmeter to test the continuity of the cables in question.

j. In the event all of the above tests check ok, and TP2, TP16, TP17, or TP18 on the Modulation Encoder still measures 7.5VDC, measure TP32.

   1. If this test point is 0VDC, troubleshoot the comparators on the Modulation Encoder.
   2. If this test point is +5VDC, troubleshoot the fault latches and fault handling IC's on the Controller.

6.4.8 Output Monitor Network VSWR

6.4.8.1 Multiple VSWR or ARC Conditions

If the transmitter is operating at reduced power or has shut itself off, and the OUTPUT MONITOR NETWORK VSWR/ANALOG INPUT POWER FOLDBACK Control front panel LEDs are illuminated RED, then more than five VSWR or ARC trips have occurred within twenty seconds in the transmitter output network. If enough successive VSWR conditions have occurred, the transmitter will foldback in power and eventually shut off.

6.4.8.2 Single VSWR or ARC

a. If the VSWR TEST Control front panel LED is illuminated RED and eventually returns to GREEN, less than five VSWR or ARC conditions have occurred within twenty seconds in the transmitter output network.

b. The NET NULL position on the front panel will normally be 0 on the meter if the transmitter is properly tuned into the antenna. Any Network VSWR will show up as an upscale meter deflection on this position.

Note

The Network VSWR circuit is inhibited during any Antenna VSWR condition.

6.4.8.3 Clear The Fault

a. The first step is to clear the fault by pressing the RESET switch on the Control front panel.

   1. If the fault clears, the transmitter should return to the normal power level and the OUTPUT MONITOR NETWORK VSWR LED should return to GREEN. If this occurs, then VSWR or Arcing is no longer present but should be monitored in the future.

6.4.8.4 Fault Will Not Clear

a. If the fault remains RED, the source of the VSWR or ARC must be repaired before full power operation can continue.

6.4.8.5 Network VSWR

a. Observe DS3 on the Output Monitor, if this indicator is flashing RED for .5 seconds, a VSWR fault is being detected.

6.4.8.6 Network ARC

a. Observe DS4 on the Output Monitor, if this indicator is illuminated RED, an Upper ARC fault is being detected.

b. Observe DS5 on the Output Monitor, if this indicator is illuminated RED, a Lower ARC fault is being detected.

c. Press the S22 reset switch, if the fault does not clear:

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

d. Turn off the transmitter and visually inspect and feel the output network components.

e. Components that are arcing will leave a black residue and possibly leave pitting marks on the inner walls, shelves and components in the transmitter.

f. If any capacitors have failed, they may feel warmer than the rest of the components in the output network.

g. If no component failures can be detected, turn on the transmitter with the air filters removed from the rear door. It might be possible to determine where the arcing is occurring by looking into the output network through the blowers.

It is possible for the network VSWR detector to be at fault.

6.4.8.7 Testing the Network VSWR Detector:

a. Turn on the transmitter and apply an RF Mute by selecting the RF MUTE position of S1 on the Controller. This keeps the power in the output network at 0W and therefore no actual VSWR should be generated.

WARNING: Disconnect primary power prior to servicing.

b. Press the VSWR TEST pushbutton on the Control front panel. The VSWR TEST LED on the panel should turn RED for 5 seconds and then return to GREEN.

c. If it does not change or remains RED, the VSWR test circuit is not operating correctly and the transmitter should not be operated until the problem is resolved.

6.4.9 Output Monitor Antenna VSWR

6.4.9.1 Multiple VSWR Conditions

If the transmitter is operating at reduced power or has shut itself off, and the OUTPUT MONITOR ANTENNA VSWR/ANALOG INPUT POWER FOLDBACK Control front panel LEDs are illuminated RED, then more than five VSWR events have occurred within twenty seconds. If enough successive VSWR conditions have occurred, the transmitter will foldback in power and eventually shut off.

6.4.9.2 Single VSWR

a. If only the OUTPUT MONITOR ANTENNA VSWR Control panel LED is illuminated RED and the transmitter is still at the normal power, less than five VSWR events have occurred within twenty seconds.

b. The ANT NULL position on the front panel will normally be 0 on the meter if the transmitter is properly tuned into the antenna. Any antenna VSWR will show up as an upscale meter deflection.

6.4.9.3 Clear The Fault

a. The first step is to clear the fault by pressing the RESET switch on the Control front panel.

   1. If the fault clears, the transmitter should return to the normal power level and the OUTPUT MONITOR NETWORK LED should return to GREEN. If this occurs, then a VSWR fault is no longer present but should be monitored in the future.

6.4.9.4 Fault Will Not Clear

a. If the fault remains RED, the source of the VSWR fault must be repaired before full power operation can continue.

Some possible causes of antenna VSWR are:

a. ARCING

   1. Static discharge or discharge due to lightning across ball gaps, guy wire insulators, or possibly across components already operating close to their voltage ratings.
   2. Static charge buildup can occur on towers that do not have provision made for static discharge, such as static drain chokes.
   3. Static charge buildup can occur during under conditions of rain, snow, or even blowing dust or sand.
   4. Dirt build up or moisture (including condensation) on insulating surfaces and inside a transmission line can cause the voltage breakdown rating to be reduced. This can occur if pressurized gas filled lines lose pressure or if the dehydrator in the line pressurization unit fails.
   5. In new systems, insufficient voltage rating of components, such as capacitors, insulators, or spark gaps may be set too close.

b. TRANSIENT signal pickup may occur during thunderstorms, even from distant lightning strikes in some cases. Lightning strokes may induce currents in towers, causing currents on the transmission lines that can reach the phase detectors and give a VSWR overload indication.

c. INTERFERENCE: Other nearby stations' signals can also induce voltages and currents in antenna systems that are large enough to be detected by the phase detector and cause VSWR overloads. The solution in such cases may be a trap or filter in the antenna impedance matching network or phaser.

d. LOAD IMPEDANCE CHANGES - The Reflected Power reading and Antenna Null position on the front panel multimeter is the best indication of the antenna operating impedance once initially tuned into the antenna. If the Reflected Power and Antenna null indications change this indicates an impedance change of the transmitter load. The load impedance should be checked with proper impedance measuring equipment, and the improper load should be corrected if possible.

It is possible for the network VSWR detector to be at fault.

6.4.9.5 Testing the Antenna VSWR Detector:

a. Turn on the transmitter and apply an RF Mute by selecting the RF MUTE position with S1 on the Controller.

b. This keeps the power in the output network to 0W and therefore no actual VSWR should be generated.

c. Press the VSWR TEST pushbutton on the Control panel. The VSWR TEST LED on the panel should turn RED for 4 seconds and then return to GREEN.

d. If it remains RED, the VSWR test circuit is not operating correctly and the transmitter should not be operated until the problem is resolved.

6.4.10 VSWR Test

The VSWR TEST LED is an indicator that the transmitter is performing a VSWR TEST, a VSWR fault or ARC has just occurred, or that the VSWR detector has failed. When the transmitter is first turned on or when a different power level is selected, this LED should illuminate RED for 4 seconds and then return to GREEN. If during normal operation, the LED is illuminated RED and does not return to green within 4 seconds, the VSWR circuits may have failed and should be tested to determine if they are operating properly.

Note

Pressing the front panel reset has no effect on this indicator. This LED can only be reset by a successful completion of the VSWR test. If the LED remains RED after 4 seconds, troubleshoot the VSWR TEST circuit.

a. If the VSWR TEST pushbutton is pressed while S21 is depressed and held down on the Output Monitor, the VSWR TEST LED should remain RED. If this occurs, the VSWR TEST circuit (which is Inhibited by S21) will not have detected a VSWR and should remain illuminated RED indicating that the circuit failed the test. This is a

WARNING: Disconnect primary power prior to servicing.

way of being sure that the detector circuit will return a fault to the front panel, if one does occur.

6.4.11 Output Monitor Supply Fault

If the transmitter has shut itself off or is operating with an RF Mute indicator lit, and the OUTPUT MONITOR SUPPLY FAULT LED on the Control front panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the Output Monitor.

a. F1 should measure +22VDC, F2 should measure +8VDC, and F3 should measure -22VDC. If any one of these supplies is not present, troubleshoot the low voltage power supplies.
b. If all of these supplies are present, refer to the Troubleshooting section of the Output Monitor board.

6.4.12 Analog Input Power Foldback

This LED is not a fault indicator, but rather an indication that the transmitter is, or has been, in a self protection mode.

6.4.12.1 Reset the Fault

a. If the FAULT RESET pushbutton on the Control front panel is pressed and the LED returns to GREEN, then the fault that caused the foldback is no longer present and the condition should be monitored.
b. If the LED remains RED after the FAULT RESET pushbutton is pressed, then the fault that caused the foldback is still present.
    1. The transmitter will normally be in the foldback mode due to Antenna/Network VSWR or ARC, RF Amp/Power Supply Temp, or Air Flow Reduced faults.
    2. The transmitter can also be in this mode due to failures of the sensing and control circuitry. Refer to the appropriate fault section or to the troubleshooting guide of the Controller and/or Analog Input board as needed.

6.4.13 Analog Input Supply Fault

If the transmitter has shut itself off or is operating with an RF Mute indication, and the Analog Input Supply Fault LED on the Control front panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the Analog Input board.

a. F3 should measure +22VDC, F2 should measure –22VDC, and F1 should measure -+8VDC. If any one of these supplies is not present, troubleshoot the low voltage power supplies.
b. If all of these supplies are present, refer to the Troubleshooting portion of Section J, Analog Input board.

6.4.14 A/D Converter Conversion Error

If the transmitter is operating but has 0W output, and the RF MUTE and A/D Converter Conversion Error LEDs on the Control front panel are illuminated RED, then the RF sample required by the A/D Converter is not present or there is a fault in the A/D conversion process.

a. With an oscilloscope, measure the RF squarewave signal across R11, on the A/D Converter.
    1. If the RF squarewave signal is present across R11, refer to the Troubleshooting section for the A/D Converter.
b. If no signal is present, check the RF signal at TP4 A/D Phase on the Driver Encoder.
    1. If the signal is present at TP4, then check the continuity of the cable that connects the A/D Converter to the Driver Encoder, through the Transmitter Interface.
c. If the RF signal is not present at TP4, check for an RF signal across R106 on the Driver Encoder.
d. If there is no signal across R106, then check continuity of the cable that connects the Driver Encoder to the RF Splitter.
e. If the signal is present at R106 but not at TP4, refer to the Troubleshooting section for the Driver Encoder.

6.4.15 A/D Converter Supply Fault

If the transmitter has shut itself off or is operating with an RF Mute indicator lit, and the A/D Converter Supply Fault LED on the Control panel is illuminated RED, then one or more power supplies has failed on this board. With the low voltage on, measure the following voltages on the A/D Converter board.

a. F1 should measure +22VDC, F2 should measure -22VDC, F3 should measure +8VDC, and F4 should measure -8VDC. If any one of these supplies is not present, troubleshoot the low voltage power supplies.
b. If all of these supplies are present, refer to the Troubleshooting portion of Section K, A/D Converter board.

6.4.16 Encoder Module/Cable Interlock

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, an RF Amplifier(s), Driver(s), or encoder cable(s) has been disconnected.

a. Open all of the front doors and observe DS2-Interlock 4, DS3-Interlock 3, DS4-Interlock 2, and DS5-Interlock 1 on all Modulation Encoders and DS8-Interlock on the Driver Encoder.
b. If any one of these LEDs are illuminated RED, the cause of the fault has been detected by that circuit.
c. If no indicator is lit, then an open exists between the different Modulation encoders or the fault sensing circuit has failed.
    1. Check the inputs and output of U3 on the Transmitter Interface board to discover which signal is being interrupted.
    2. Ohmmeter check the appropriate cable if an input is missing or low.
    3. Refer to the Troubleshooting Section of the Controller if the output of U3 is high.

6.4.16.1 Modulation Encoder Module/Cable Interlock

a. If DS2, DS3, DS4, or DS5 is illuminated RED on a Modulation Encoder, refer to the Modulation Encoder

WARNING: Disconnect primary power prior to servicing.

Firing Order Diagram to determine which set of eight RF Amplifiers is connected to that interlock.

For example:

If DS3 is illuminated RED on the A27 Modulation Encoder then RF Amplifiers RF101 through RF108 or the encoder cable is not connected or open. This example will be used for the rest of the troubleshooting procedures, and applies to any other interlock that is illuminated RED.

To find a Module/Cable interlock fault, based on the above example, use the following procedures:

b. Use an ohmmeter to measure for continuity from Cathode of CR39 to R122 (J3-9 to J3-19). If the resistance measures open, then disconnect the J3 plug and measure for continuity from J3-9 to J3-10 and the continuity from J3-19 to J3- 20.

1. If the resistance from 9 to 10 is open, the cable that connects to J18 on RF Combiner Motherboard, A13, is open or RF Amplifiers RF101 through RF104 are not properly making connection to the RF Combiner Motherboard edge connectors.
2. If the resistance from 19 to 20 is open, the cable that connects to J19 on RF Combiner Motherboard, A13, is open or RF Amplifiers RF105 through RF108 are not properly making connection to the RF Combiner Motherboard edge connectors.
3. Try pulling out each RF Amplifier and pushing it back into the connector, verify that the cables are properly inserted into the connectors on the RF Combiner Motherboard, and if needed ohmmeter check the encoder cable wires.

c. If the ohmmeter resistance from J3-9 to J3-19 measures 0 Ohms, disconnect the J3 plug and check the resistance across CR39. A normal diode reading should be obtained. If not then troubleshoot the Modulation Encoder by referring to the Troubleshooting portion of Section L, Modulation Encoder.

6.4.16.2 Driver Encoder Module/Cable Interlock

If DS8 is illuminated RED on the Driver Encoder, then one of the Driver amplifiers or the encoder cables is not connected or open.

a. Using an ohmmeter, measure for continuity from J2-20 to J2-9. If continuity exists, then disconnect J2 and repeat the measurement. The resistance should rise. If not, troubleshoot the Cable Interlock circuitry by referring to the Troubleshooting section for the Driver Encoder.

b. If there is no continuity between J2-20 and J2-9 then disconnect J2 from the Driver Encoder and measure for continuity between P2-20 and P2-19 and between P2-9 and P2-10.

1. If the resistance from 19 to 20 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.
2. If the resistance from 9 to 10 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.

c. Using an ohmmeter, measure for continuity from J1-20 to J1-9. If continuity exists, then disconnect J1 and repeat the measurement. The resistance should rise. If not, troubleshoot the Cable Interlock circuitry by referring to the Troubleshooting section for the Driver Encoder.

d. If there is no continuity between J1-20 and J1-9 then disconnect J1 from the Driver Encoder and measure for continuity between P1-20 and P1-19 and between P1-9 and P1-10.

1. If the resistance from 19 to 20 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.
2. If the resistance from 9 to 10 is open, the cable that connects to the Driver Combiner Motherboard is open or one of 4 Driver Amplifiers is not properly making connection.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

e. Try pulling out each Driver Amplifier and pushing it back into the connector, verify that the cables are properly inserted into the connectors on the Driver Combiner Motherboard, and if needed ohmmeter check the Encoder cable wires.

6.4.17 Encoders Supply Fault

If the transmitter has shut itself off, and the above LED is illuminated RED, a power supply on one of the Modulation Encoders, or on the Driver Encoder has failed. The first step is to determine if it is a Modulation Encoder or Driver Encoder Fault.

a. Depress S6, and observe DS9 on each Modulation Encoder and DS7 on the Driver Encoder.

6.4.17.1 Modulation Encoder Supply Fault

a. If DS9 on a Modulation Encoder is illuminated RED, depress S6 on that encoder and hold for a few seconds while observing DS8, B+ and DS11, B-.

b. DO NOT DEPRESS S6 FOR LONGER THAN 1 MINUTE.

1. If either of the LEDs do not illuminate GREEN, check for -10VDC at TP22 and +10VDC at TP10. If either of these voltages are not present, troubleshoot the low voltage supplies.

WARNING: Disconnect primary power prior to servicing.

Note

The B- LED, DS11, will probably be dimmer than the B+ LED, DS8.

NOTE

It is possible to bypass a failed Modulation Encoder and operate the transmitter at a reduced power level. Refer to the Emergency Bypass section in the manual for the proper procedure.

2. If the supplies are present, troubleshoot the B+/B- regulators referring to the Troubleshooting section for the Modulation Encoders.
3. If both LEDs illuminate GREEN, troubleshoot the B+/B-fault comparators referring to the Troubleshooting section for the Modulation Encoders.

6.4.17.2 Driver Encoder Supply Fault

DS8 on the Driver Encoder is illuminated RED.

a. Check for +22VDC on J5-1, +8VDC on J5-5, and -22VDC on J5-7. If any of these voltages are not present, troubleshoot the low voltage power supplies.
   1. If the supplies are present, troubleshoot the regulators referring to the Troubleshooting section for the Driver Encoder.

6.4.18 RF Amp Power Supply A/C Mains Fault

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, then

a. Low or high voltage A/C input is no longer present, or
b. An imbalance (low phase) exists in the 3-phase A/C input supply, or
c. The 3-phase A/C input supply voltage is low, or
d. There is a failure in the fault sensing circuit.

Observe 3PH A/C MAINS PROTECTION ACTIVE indicators PH1/PH2/PH3 and SINGLE PHASE A/C MAINS PROTECTION ACTIVE indicators PH1/PH2 on the power supply control panel.

a. If any of these indicators are not illuminated GREEN, measure the A/C input feeding the transmitter.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Due to the voltages present it will be necessary to clip test leads between any 2 phases on the top of K2 and route the test leads outside the transmitter to an A/C voltmeter. Replace the cover before reapplying power. Do not hold the meter in your hand.
c. Determine that the 3 phase line voltages are within 8% of each other and not less than 80% of the rated supply. If the line voltages are not in balance, the power source should be checked in order to rectify the problem.
d. Repeat this procedure for all phase combinations. Then shut off all power at the wall disconnects, remove the test leads and replace all covers before reapplying power to the transmitter.
e. If this fault occurs only intermittently, the power supply balance is marginal and is probably alarming on low frequency modulation peaks.
   1. Measure the +12 Volt Controller power supply at C7.
   2. If the voltage is 10.5 Volts or less, measure one phase and verify transformer taps of T5.
f. Measure the voltage on U22-7 of the Controller. If this voltage is a logic high then refer to the Troubleshooting section of the Controller.

6.4.19 RF Amp Power Supply Current Fault

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, a current fault has occurred two times in succession, i.e. a second fault was detected within four seconds of the transmitter restart. If the transmitter is still operating, only one current fault has occurred. The current fault circuit monitors the actual supply current and will generate a fault any time the peak current reaches a preset overload level or the average current limiting cannot limit the maximum supply current of 900A. Turn on the transmitter and observe fault symptoms.

a. If the transmitter has random faults with audio, and the current limiting LED on the Analog Input board is red, or flashing red, this indicates that the average overload current is being exceeded. This is most commonly caused by excessive audio levels, excessive low frequencies or by subaudible signals overmodulating the transmitter. The modulation level should not exceed +13dBm over the normal audio level. Check your modulation level on an oscilloscope to see if audio level should be reduced to prevent overmodulation. This would be indicated by severe clipping.
b. If the transmitter will not stay on because of the overload, set the RF MUTE switch to ON.
   1. If PA current meter on the front panel moves upscale when the step-start sequence is started, then the problem is most likely due to a problem in the power supply. (The power supply can be isolated from the RF Amplifiers by removing fuses on the Fuse Boards as described in the Initial Turn-On Procedure Section.)

Note

If there is a Current fault and Voltage fault on the Control front panel display, then there is most likely a short on the 230VDC supply. This would also be accompanied by Buffer, Predriver, Low Drive and A/D Conversion Error indicators.

c. If the PA Current meter does not deflect, and the fault is not repeated with the RF Mute on, refer to the troubleshooting portion of Section J, Analog Input and/or Section K, A/D Converter.

6.4.20 RF Amp Power Supply Voltage Fault

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, the supply voltage is either over 270VDC or under 115VDC.

a. Turn on the transmitter and observe the PA+VDC front panel meter position.
b. If the transmitter will remain on the air long enough to measure the Supply voltage on the front panel multimeter, compare this reading to that recorded on the factory test data sheet.
c. If the reading is significantly lower, a short may exist in the high voltage supply. This is because a voltage fault will be detected before a current trip by the Controller.

Note

If the PA +VDC is high or low, check the A/C mains for a variation from the normal readings. If the A/C main voltages are significantly different from when the transmitter was installed, and appear to be stable at the new voltage level, it may be necessary to retap the transformers.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. The 230VDC bus bar grounding switches should be checked for an open when the door is closed.
2. The High Voltage Crowbar circuit should be checked for shorts.
3. The fuses on the High voltage transformer should also be checked for any opens.

d. If the voltage is within the Test Data limits then the sensing circuitry may have failed. Refer to the Controller section for Troubleshooting the failure.

6.4.21 RF Amp Power Supply Temp Fault

If the transmitter has shut itself off or is running at a reduced power level and the above LED is illuminated RED on the Control front panel, possibly along with the ANALOG INPUT POWER FOLDBACK, then the temperature inside the power supply is too high. Temperature sensors U1, U2, U3, and U4 are mounted on the power supply rectifier heatsinks and monitor the temperature for Supply A and Supply B.

a. Open the right PA cabinet and observe DS1 and DS2 on the Driver Encoder.
   1. If DS2 is illuminated RED, Supply A is overtemperature and if DS1 is illuminated RED Supply B is overtemperature.

6.4.21.1 Indicator DS1 or DS2 Illuminated

a. Measure the ambient intake air, it should be less than 50 degrees C.
b. Inspect the air filters, if they are clogged with dirt or sand they will reduce air flow.
c. Verify the blowers are operational and that no blades are loose. Also check the exhaust air path to make sure there are no obstructions that could cause excessive back pressure to the cabinet.
d. If intake air and air flow are normal, one of the supplies could have failed. If the temperature of the rectifier heatsinks is more than 65°C troubleshoot the +230VDC power supplies.
e. Excessive current with a high ambient temperature and/or a slight imbalance in the power supply can cause excessive heating of the rectifier heatsinks.

6.4.21.2 No Indicators Illuminated

a. If no indicator is lit and the transmitter has reduced power to a low level or a failure in the fault sensing circuit has occurred:
   1. Depress the Fault Reset button on the Control front panel.
   2. If the power returns to normal, monitor the transmitter and Driver Encoder DS1 and DS2 LEDs for a repetition of the fault.
   3. If the transmitter does not return to full power and no DS1 or DS2 indicators are lit on the Driver Encoder then the fault sensing circuitry has failed.
b. Check the voltage at the cathode of CR5 on the Transmitter Interface Board.
   1. If this is a logic high then refer to the Controller Section of the manual for troubleshooting.
   2. If low refer to the troubleshooting section of the Driver Encoder to locate this fault.

6.4.22 Remote Control, Local

If the above LED is illuminated RED on the Control front panel, the transmitter is in the local control mode and all extended/remote control functions are no longer active. Local control is active even when the Remote control is enabled.

6.4.23 Remote Control, Remote

If the above LED is illuminated GREEN, the transmitter is in the remote control mode and all extended/remote control functions are active. All local functions are also still active.

6.4.24 Door Interlock

If the transmitter has shut itself off or cannot be turned on and the above LED is illuminated RED on the Control front panel, a door interlock or ground stick switch has not been properly closed.

a. Open the front center door and observe DS1 and DS2 on the Transmitter Interface.
b. If DS1 is illuminated RED, check to make sure that the captive hardware is securely fastening all three front doors of the compartments containing the PA and RF driver modules to the cabinet. When all front doors are properly closed, DS1 will extinguish. Observe DS2.

c. If DS2 is illuminated RED, check to make sure that the captive hardware is securely fastening all five rear doors to the cabinet.

d. If DS2 is still illuminated:

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

e. Open the rear door of the Output Network cabinet and ensure that both grounding sticks are properly inserted into their holders.

f. If the doors appear to be closing properly and the ground stick switches are closed, then measure the voltage at the cathode of CR7 on the Transmitter Interface.

1. If the transmitter is in the Standby mode, this voltage should be near +12VDC.
2. If the transmitter is in the Normal mode, this voltage should be +22VDC.
3. If no voltage is present, refer to troubleshooting the low voltage power supplies, in this section.

g. Check the input to U24-18 on the Controller. If this is a logic high then refer to the Controller section of the Manual for troubleshooting.

Note

It is possible, although unlikely, that one of the interlock switches is defective, or that there is an open in one of the interconnecting wires.

6.4.25 External Interlock

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, the external interlock is open.

a. Measure the resistance of the wires connecting to J6-10 and J6-11 on the External Interface.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If the resistance measurement is open, check all devices connected to these terminals, (phaser door interlock, dummy load, etc.) to make sure that the device is providing closed contacts in the normal operating condition.

c. If the resistance measurement is 0 Ohms, measure the voltage at the cathode of CR37 on the External Interface.

1. This voltage should be +12VDC if the transmitter is in the Standby mode and +22VDC in the Normal mode.
2. If no voltage is present, verify that the combiner interlock, P29, on the External Interface is in the correct position.
3. If no voltage is present, troubleshoot the low voltage supplies.

d. Check the input of U24 on the Controller. If this is a logic high, refer to the Controller Section for troubleshooting.

6.4.26 Controller RF Mute

If the transmitter is operating at 0W output and the above LED is illuminated RED on the Control front panel, the transmitter is responding to another fault by applying an RF MUTE or a control input has been activated. Check that an external RF Mute or S1 on the controller is not in the Mute position.

If no other indicators are lit refer to the Controller Section of the Manual for troubleshooting the Controller.

6.4.27 Controller Supply Fault

If above LED is illuminated RED on the Control front panel, then one of the power supplies on this board has failed. With the low voltage on, measure the following voltages on the Controller.

a. If P53 on the Controller is jumpered 2-3, TP21 should measure +12VDC.

b. If P53 is jumpered 1-2, TP22 should measure +10VDC.

c. If any one of these supplies is not present, troubleshoot the low voltage power supplies.

d. If all of these supplies are present, refer to the Troubleshooting portion of Section M, Controller board.

6.4.28 Air Flow Reduced

If the transmitter is operating at a reduced power level, and the above LED along with the ANALOG INPUT POWER FOLDBACK is illuminated RED on the Control front panel, then air cooling for the transmitter is reduced.

To determine which cabinet(s) have reduced airflow, open all front doors and observe DS7 on all Modulation Encoders and DS1 on the Output Monitor.

a. Modulation Encoder A28 monitors the Left PA Cabinet

b. Modulation Encoder A26 monitors the Center PA Cabinet

c. Modulation Encoder A25 monitors the Right PA Cabinet

d. The Output Monitor Board monitors the Output Network Cabinet

If any of these LEDs is illuminated RED, perform the following checks for that cabinet.

a. Measure the ambient intake air, it should be less than 50 degrees C.

b. Inspect the air filters, if they are clogged with dirt or sand they will reduce air flow.

c. Verify the blowers are operational and that no blades are loose.

d. Check that the exhaust airflow is not obstructed creating excessive back pressure in the cabinet(s).

6.4.29 Air Flow Fault

If the transmitter has shut itself off and the above LED is illuminated RED on the Control front panel, air flow has been reduced enough to turn off the transmitter.

Refer to the above AIR FLOW REDUCED section to determine the problem.

6.5 Troubleshooting Frequency Control Panel Faults

NOTE

All faults of this type will cause an RF Mute to be applied to the transmitter

6.5.1 Frequency Synthesizer/RF Mute

If these front panel LEDs are illuminated RED, this indicates that the selected frequency is out of range.

6.5.1.1 Incorrect Frequency Switch Outputs

Check the 4-4 bit BCD input to the Synthesizer Interface Board.

a. Select F1 on the front panel.

b. Measure the logic level inputs to the Synthesizer Interface on J6. They should be as follows:

Input	Logic Level
MSD1	0
MSD2	0
MSD4	0
MSD8	0
2MSD1	1
2MSD2	0
2MSD4	1
2MSD8	0
3MSD1	0
3MSD2	0
3MSD4	0
3MSD8	1
LSD1	1
LSD2	0
LSD4	1
LSD8	0

c. If the inputs are incorrect, check the 3F Control Board.

d. If the inputs are correct, refer to the troubleshooting section for the Synthesizer Interface board.

6.5.2 Bandswitch Fault/RF Mute

If these front panel LEDs are illuminated RED, this indicates a loss of +24VDC or an open interconnect cable in one of the Bandswitched circuits.

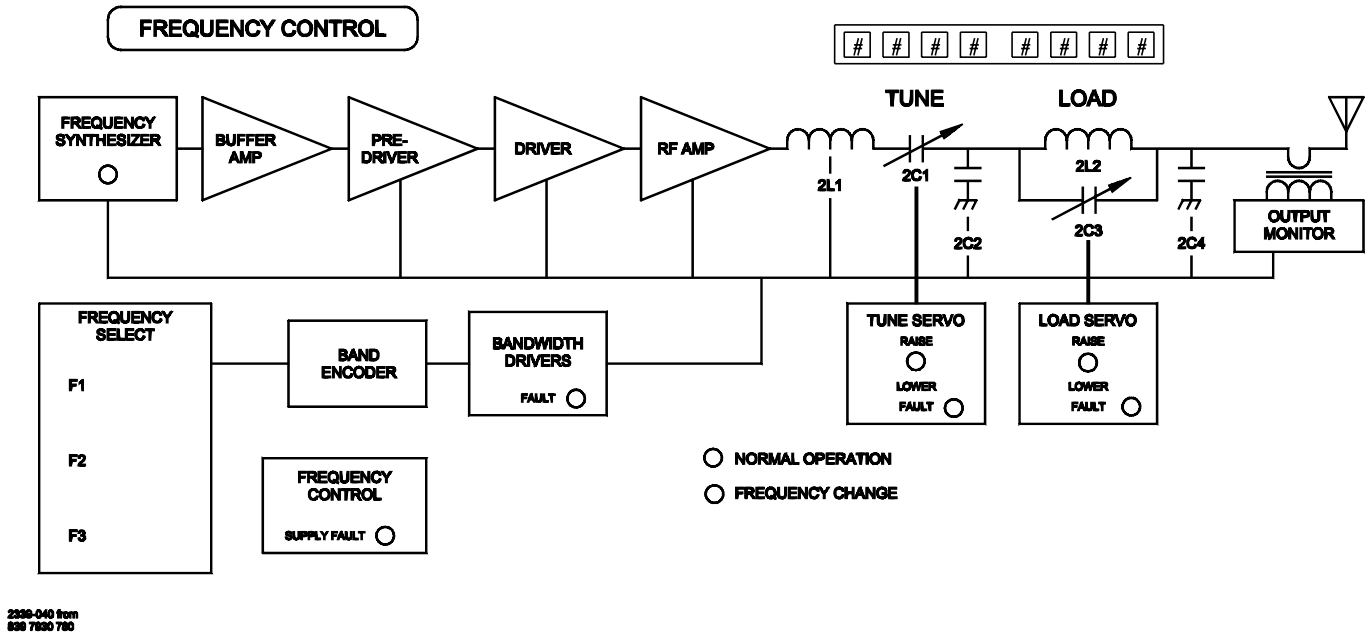

Figure 6-2. Frequency Control Front Panel

WARNING: Disconnect primary power prior to servicing.

NOTE

It is normal to see a Bandswitch Fault during the short time when the 2L1 Inductor Switch assemblies A8 and A9 are between their open/closed positions.

6.5.2.1 Measure the +24VDC relay supply using TUNE Multimeter. If the supply is missing, check F12 and troubleshoot the supply.

6.5.2.2 Make sure all cables on the Frequency Control Interface board are connected.

6.5.2.3 Observe LED bar graph DS10 and make the following measurements on the Frequency Control Interface board.

6.5.2.4 Left Compartment Illuminated

a. Ensure that P3 is properly installed.

b. Measure the voltage across F6, it should be 0VDC.

1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.

c. Measure the voltage at TP11, it should be +24VDC.

1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.

d. If the voltage is 0VDC, unplug P3 and ohmmeter check the resistance from P3-3 to P3-8.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If the pins are open, use the overall wiring diagram and the schematic for the Efficiency Coil boards to find the open connection.

6.5.2.5 Center Compartment Illuminated

a. Ensure that P4 is properly installed.

b. Measure the voltage across F5, it should be 0VDC.

1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.

c. Measure the voltage at TP8, it should be +24VDC.

1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.

d. If the voltage is 0VDC, unplug P4 and ohmmeter check the resistance from P4-3 to P4-8.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If the pins are open, use the overall wiring diagram and the schematic for the Efficiency Coil boards to find the open connection.

6.5.2.6 Right Compartment Illuminated

a. Ensure that P5 is properly installed.

b. Measure the voltage across F3, it should be 0VDC.

1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.

c. Measure the voltage at TP9, it should be +24VDC.

1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.

d. If the voltage is 0VDC, unplug P5 and ohmmeter check the resistance from P5-3 to P5-8.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If the pins are open, use the overall wiring diagram and the schematic for the Efficiency Coil boards to find the open connection.

6.5.2.7 Driver Illuminated

a. Ensure that P6 is properly installed.

b. Measure the voltage across F4, it should be 0VDC.

1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.

c. Measure the voltage at TP10, it should be +24VDC.

1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.

d. If the voltage is 0VDC, unplug P6 and ohmmeter check the resistance from P6-3 to P6-8.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If the pins are open, use the overall wiring diagram and the schematic for the Efficiency Coil boards to find the open connection.

NOTE

There are only two Efficiency Coil boards on the Driver Combiner Motherboard.

6.5.2.8 Predriver Illuminated

a. Ensure that P1 is properly installed.
b. Measure the voltage across F1, it should be 0VDC.
   1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.
c. Measure the voltage at TP1, it should be +24VDC.
   1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.
d. If the voltage is 0VDC, unplug P1 and ohmmeter check the resistance from P1-8 to P1-15.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If the pins are open, use the overall wiring diagram and the schematic for the Predriver Tuning board to find the open connection.

6.5.2.9 Driver Illuminated

a. Ensure that P2 is properly installed.
b. Measure the voltage across F2, it should be 0VDC.
   1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.
c. Measure the voltage at TP5, it should be +24VDC.
   1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.
d. If the voltage is 0VDC, unplug P2 and ohmmeter check the resistance from P2-8 to P2-15.
   1. If the pins are open, visually inspect the jumper on the plug and the contacts to find the open connection.

6.5.2.10 2C2/2L1 Illuminated

a. Ensure that P7, P8, and P21 are properly installed.
b. Measure the voltage across F7, it should be 0VDC.
   1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using the 2C3/2C4 interlock line as a reference.
c. Measure the voltage at TP15, it should be +24VDC.
   1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.
d. If the voltage is 0VDC, unplug P8 and ohmmeter check the resistance from P8-15 to P8-8.
   1. If the pins are open, visually inspect the jumper on the plug and the contacts to find the open connection.
e. Unplug P21 and ohmmeter check the resistance from P21-9 to P21-5.
   1. If the pins are open, visually inspect the jumper on the plug and the contacts to find the open connection.
f. Unplug P7 and ohmmeter check the resistance from P7-9 to P7-5.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. If the pins are open, visually inspect the position of the 2A8 and 2A9 Inductor Switches. They should either be fully retracted (switch open) or fully extended (switch closed) position.
g. If either switch is between positions, measure the AC supply, ohmmeter check the motor, and troubleshoot the K1 control circuits.
h. If both switches are in the proper position measure the resistance from J2-9 to J3-9, it should normally be 0 Ohms.
   1. If it measures open, ohmmeter test S3 & S4 and replace if required.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

2. If the switches check normal, use the overall wiring diagram to trace the interconnecting wires and cables between the assemblies to find the open circuit.

6.5.2.11 2C3/2C4 Illuminated

a. Ensure that P10 is properly installed.
b. Measure the voltage across F8, it should be 0VDC.
   1. If it measures +24VDC, replace the fuse and measure again. If the fuse opens again, measure the interlock line resistance using another interlock line as a reference.
c. Measure the voltage at TP20, it should be +24VDC.
   1. If the voltage is +24VDC, refer to the troubleshooting section for the Frequency Control Interface board.
d. If the voltage is 0VDC, unplug P10 and ohmmeter check the resistance from P10-8 to P10-15.
   1. If the pins are open, visually inspect the jumper on the plug and the contacts to find the open connection.

6.5.3 Tune Servo Fault/RF Mute

If these front panel LEDs are illuminated RED, this indicates that the Tune Servo may be out of position.

NOTE

In the Normal Operation mode, the Tune Servo Fault LED is not illuminated and the Multimeter is turned off. If this fault occurs the LED will be illuminated RED and the Multimeter will be automatically turned on.

6.5.3.1 Position Out Of Range

This fault occurs when the Position voltage is more than .5V from the Reference voltage in either a positive or negative direction. For example if the servo Reference is set for 2.5 and the servo Position is 3.0, the fault will occur. If the servo Reference is 2.5 and the Position is 2.1, the fault will not occur. Possible reasons why this fault might occur are as follows:

a. Improperly set Reference voltage when in the Frequency Change mode.
   1. Check to make sure the Reference voltage is properly set using the Transmitter Band Chart.
b. If the peak in power occurs far enough away from the Reference to cause the fault, it indicates a possible failure of Bandswitched components 1C1, 2C5, or 2L1.
c. Use the Band Indicator on the Frequency Control Interface board to check for the proper relay drive outputs for the selected frequency.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. If the outputs are correct measure the coil resistance of the relays, check the Inductor Switch operation, and visually inspect the components.
   2. If the outputs are not correct, refer to the Troubleshooting section for the Frequency Control Interface board.

6.5.3.2 A/C Power Failure

This fault will occur along with the Load Servo Fault when A/C power has been removed long enough for the battery backup supply to depleted. The transmitter will have to be manually retuned to the selected frequency before normal operation can resume.

6.5.3.3 Servo Supplies Missing

a. With only the low voltage on, observe the +20VDC DS7 and -20VDC DS9 indicators on the Frequency Control Interface board.
   1. If they are not illuminated GREEN, verify that the Servo Supply circuit breaker is in the on (up) position and that F13 and F14 on the Frequency Control Interface board are not open.
   2. Troubleshoot the Servo Supply if needed.
b. Observe the +15VDC DS1 and -15VDC DS2 indicators on the Frequency Control Interface board when the Tune Raise/Lower switch is activated.
   1. If both indicators do not illuminate GREEN for 60 seconds, refer to the Troubleshooting section for the Frequency Control Interface board.
c. Measure voltages at the Tune Servo Output on TP38.
d. When the servo Raise/Lower is activated, the voltage should switch between + and - output polarity.
   1. If there is no output or no change, refer to the Troubleshooting section for the Frequency Control Interface board.
e. Measure the Position Feedback at J13-1 if the servo is operational.
f. The voltage should vary from 0 .7VDC to 13VDC as the servo travels from one mechanical stop to the other.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. If the voltage does not change, visually inspect and measure the resistance of the position potentiometer on the assembly.

6.5.3.4 Mechanical

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Visually inspect the belts, gears, pulleys, couplers, and contacts of the assembly.

6.5.4 Load Servo Fault/RF Mute

If these front panel LEDs are illuminated RED, this indicates that the Load Servo may be out of position.

NOTE

In the Normal Operation mode, the Load Servo Fault LED is not illuminated and the Multimeter is turned off. If this fault occurs the LED will be illuminated RED and the Multimeter will be automatically turned on.

6.5.4.1 Position Out Of Range

This fault occurs when the Position voltage is more than .5V from the Reference voltage in either a positive or negative direction. For example if the servo Reference is set for 2.5 and the servo Position is 3.0, the fault will occur. If the servo Reference is 2.5 and the Position is 2.1, the fault will not occur. Possible reasons why this might happen are as follows:

a. Improperly set Reference voltage when in the Frequency Change mode.
   1. Check the to make sure the Reference voltage is properly set using the Transmitter Band Chart.

b. If the peak in power occurs far enough away from the Reference to cause the fault, it indicates a possible failure of Bandswitched components 2C2, 2C3, or 2C4.

c. Use the Band Indicator on the Frequency Control Interface board to check for the proper relay drive outputs for the selected frequency.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. If the outputs are correct measure the coil resistance of the relays and visually inspect the components.
   2. If the outputs are not correct, refer to the Troubleshooting section for the Frequency Control Interface board.

6.5.4.2 A/C Power Failure

This fault will occur along with the Tune Servo Fault when A/C power has been removed long enough for the battery backup supply to depleted. The transmitter will have to be manually retuned to the selected frequency before normal operation can resume.

6.5.4.3 Servo Supplies Missing

a. With only the low voltage on, observe the +20VDC DS7 and -20VDC DS9 indicators on the Frequency Control Interface board.
   1. If they are not illuminated GREEN, verify that the Servo Supply circuit breaker is in the on (up) position and that F13 and F14 on the Frequency Control Interface board are not open.
   2. Troubleshoot the Servo Supply if needed.

b. Observe the +15VDC DS1 and -15VDC DS2 indicators on the Frequency Control Interface board when the Tune Raise/Lower switch is activated.
   1. If both indicators do not illuminate GREEN for 60 seconds, refer to the Troubleshooting section for the Frequency Control Interface board.

c. Measure voltages at the Load Servo Output on TP37.

d. When the servo Raise/Lower is activated, the voltage should switch between + and - output polarity.
   1. If there is no output or no change, refer to the Troubleshooting section for the Frequency Control Interface board.

e. Measure the Position Feedback at J13-3 if the servo is operational.

f. The voltage should vary from 0 .7VDC to 13VDC as the servo travels from one mechanical stop to the other.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

   1. If the voltage does not change, visually inspect and measure the resistance of the position potentiometer on the assembly.

6.5.4.4 Mechanical

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Visually inspect the belts, gears, pulleys, couplers, and contacts of the assembly.

6.5.5 Power Supply Fault/RF Mute

If these front panel indicators are illuminated, a power supply fault has occurred on the Frequency Control or Frequency Control Interface board. Observe the Power Supply Fault indicators on both boards.

6.5.5.1 DS16 On Frequency Control Board Illuminated RED

a. Measure the +8VDC at J7-5.
   1. If the supply is not present, troubleshoot the Low Voltage Supplies.
   2. If the supply is present, refer to the Troubleshooting section for the Frequency Control board.

6.5.5.2 DS3 On Frequency Control Interface Board Illuminated RED

a. Measure the +22VDC, 8VDC, and -22VDC inputs at J11.
   1. If any supply(s) is not present, troubleshoot the Low Voltage Supplies.
   2. If all the supplies are present, refer to the Troubleshooting section for the Frequency Control board.

6.6 Troubleshooting Faults on the Power Supply Status Panel

The faults on the Power Supply Front Panel are indicated by a light being extinguished or a breaker tripped.

6.6.1 3 PH A/C Mains Protection Active

If these lights are out and the A/C Mains Input Monitor indicates A/C present then an MOV has shorted and/or the associated fuse has failed.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

Check the MOV before replacing the fuse.

If only one of the lights is out, there has been a change in the Main A/C Supply to the transmitter that resulted in one of the Phases being grounded to provide 120V to ground. If this has occurred refer to the Installation section, Initial Turn On, to adapt the circuit to the new power configuration.

6.6.2 RF Amplifier Power Supply 230 Volts Present

If this light is extinguished along with an A/C Mains fault on the Control front panel, the transmitter main contactor is not engaged or the RF Amp Power Supply Discharge circuit has failed.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

To check the RF Amp Power Supply Discharge circuit:

a. Remove the upper Front Power Supply Panel.
b. With an ohmmeter, check for a short on the power supply by connecting the negative lead to the ground stud above TB11 and the positive lead to the TB12-8 (see VIEW 6). The resistance should be 450 Ohms +/-10%.
   1. If the resistance is less than 450 Ohms check the MOSFETs Q1 through Q4.
c. Also, check to verify the Door Shorting Switches open when the doors are closed.

6.6.3 No Single Phase A/C Protection Active

If both of these indicators are out there is no single Phase A/C present in the transmitter or the protection circuitry has failed.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. To check the protection circuit,
   1. Ohmmeter test F1 and F2 on the rear wall next to the Main Contactor for an open.
   2. If a fuse is open check the MOV before replacing the fuse.
b. If only one indicator is illuminated the protection for that side of the A/C line has failed or the A/C power is configured such that one side of the A/C line is ground.
c. If the incoming A/C measures 120 Volts to ground from either leg, check the fuse (F1 or F2) associated with that line for an open.
   1. If the fuse is open check the MOV before replacing the fuse.

6.6.4 Fan Status

If any of these indicators are not illuminated a fan is defective or a fan fuse has opened. Observe the fans by looking under the filter to locate the inoperative fan in the door indicated by the Status LED. If a fan is not running with the transmitter on, turn off the transmitter.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

Access the fuses for the fan by removing the cover plate from the center of the door and check for an open fuse. An open fuse would indicate a defective fan or a loss of three phase power to that fan.

If all the fans are operating, suspect the current monitor in the Power Supply cabinet to be defective.

6.7 System Faults With No Indication On The Front Panel

6.7.1 Circuit Breaker Tripping

Refer to troubleshooting Low Voltage supplies if a breaker has tripped on the Power Supply Display panel.

This part of the troubleshooting section deals with problems that may occur with the transmitter that cannot be diagnosed from the Control front panel display.

6.7.2 Transmitter Does Not Turn On, No RED Indicators on Control Front Panel.

6.7.2.1 A/C Check

a. Determine the presence of three phase and single phase A/C. A quick check is to see if the A/C protection Circuit active indicators on the Power Supply Display panel are illuminated.

b. If any of these indicators are not illuminated GREEN, measure the A/C input feeding the transmitter.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. Due to the voltages present it will be necessary to clip test leads between any 2 phases on the top of K2 and route the test leads outside the transmitter to an A/C voltmeter. Replace the cover before reapplying power. Do not hold the meter in your hand.
2. Determine that the 3 phase line voltages are within 8% of each other and not less than 80% of the rated supply. If the line voltages are not in balance, the power source should be checked in order to rectify the problem.
3. Repeat this procedure for all phase combinations. Then shut off all power at the wall disconnects, remove the test leads and replace all covers before reapplying power to the transmitter.

c. Verify that the transmitter starts from the Standby mode when a Power button is depressed. This is indicated by all LEDs illuminated on the Control front panel.

d. If the transmitter does not start from the Standby mode, switch CB3 on the Power Supply Display panel to the Normal position. If the LEDs do not illuminate refer to the Troubleshooting Low Voltage Supplies procedure in this section.

6.7.2.2 No Step-Start

a. If the transmitter does not start from the Standby mode and no action of the step-start contactor is heard, check DS1 and DS2 on the Transmitter Interface board. If either of these is illuminated an open interlock exists. Refer to the Transmitter Interface Section for a diagram of the interlock flow.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If no indicator on the Transmitter Interface is illuminated, determine the presence of +22VDC at K3.
   1. Since K3 is in a compartment with high voltages, it will be necessary to clip test leads to the appropriate points and then route the leads outside the transmitter to a voltmeter. Be sure to replace all covers and doors before returning power to transmitter.
   2. If the 22VDC is not present, then an interlock is open. Refer to the Transmitter Interface Section for a diagram of the Interlock Control String.
   3. If the +22VDC is present on K3 Turn off the A/C power, remove the meter leads and attach the cover back in place.

c. Restore all A/C power to the transmitter and check U43-7 on the Controller for a Low pulse when a power button is depressed.
   1. If a pulse is not observed, refer to the Controller Troubleshooting Section to continue.
   2. If a pulse is observed on U43-7, check K3, K1 and the wiring at TB4 in the Power Supply Cabinet.

6.7.2.3 Step Start Pulls In, Run Contactor Does Not

a. If the transmitter step start contactor pulls in and then drops out without the Run Contactor pulling in,

b. Check the cathode of CR88 on the Controller for a logic high pulse when the Step Start Contactor engages.
   1. If this pulse is not present, suspect dirty aux contacts of K1, or an open cable.
   2. If the Pulse is present on CR88 cathode, check U43-1 on the Controller for a low pulse after the step start contactor engages.
   3. If the low is present suspect K4, K2 or an open cable.
   4. If the low is not present on U43 refer to the Controller Section to troubleshoot loss of Turn on.

6.7.2.4 Step Start and Run Pull In Then Drop Out

a. This would usually be followed by some type of indication on the Control front panel display. If there are no indications on the display, then suspect:
   1. A weak K2 coil, or
   2. A loss of A/C voltage, or
   3. A Controller fault.

6.8 Troubleshooting Low Voltage Supplies

Refer to the Simplified Low Voltage Supply Diagram in the Overall System Theory section to aid in troubleshooting as needed.

Begin by verifying presence of Single Phase A/C input.

a. If the AC input is present then the "Single Phase A/C Mains Protection" indicators, on the front panel, should be lit (unless RV7 or RV8 have activated, which would cause the light to go out).

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If the A/C input is not present, then with the transmitter off, ohmmeter check F1 and F2. If either is open, replace both the fuse and the MOV (RV7 or RV8).

c. With the transmitter still off, clip meter leads to the input side of F1 and F2. Route the leads outside the transmitter and replace the cover.

d. Turn on the single phase A/C disconnect and verify A/C presence in the transmitter.

e. If it is not present, troubleshoot building A/C and the Disconnect.

f. If the voltage is present, ensure that all breakers on the Power Supply Panel are in the ON position and that CB3 is in the Normal position.

g. Shut off the Single Phase A/C wall disconnect and remove the test leads from the transmitter. Be sure to replace all covers before operating the transmitter.

6.8.1 Main Breaker (CB1) Trips

If CB1 trips upon applying Single phase A/C, then

a. Turn off CB4 (Low Voltage Supply), CB6 (Servo Supply), and CB2 (Controller Supply).

b. Apply A/C single Phase to the transmitter,
   1. If CB1 trips suspect a shorted cable, failed K5 or failed CB1.
   2. If CB1 does not trip, turn on CB4.
   3. If CB1 trips and CB4 does not suspect a weak CB1.
   4. If CB4 trips, refer to the above procedure for CB4 trips.

c. Turn off CB4 and turn on CB2; if CB1 trips and CB2 does not, suspect a weak CB1.

d. Turn off CB2 and turn on CB6; if CB1 trips and CB6 does not, suspect a weak CB1.

6.8.2 Low Voltage Supply (CB4) Trips

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. If CB4 continually trips:
   1. Disconnect the connectors on the Power Distribution boards A33 and A34.
   2. Restore Single Phase A/C.
   3. If CB4 does not trip, there is a short on a board or in the cabling.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. If CB4 still trips, then the most likely components to check would be:
   1. Rectifiers, CR43, CR44 and CR45.
   2. Filter capacitors, C8 through C13.
   3. Transformer, T6.
   4. Breaker, CB4 could be weak.

6.8.3 Controller Breaker (CB2) Trips

If CB2 trips when CB1 is set to the on position:

a. Turn off A/C power.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Disconnect wires 161 and 162 from CR46.

c. Turn the transmitter back on.

d. If CB2 trips, then suspect:

1. Rectifier, CR46
2. Transformer T5, or
3. A weak CB2.

e. If CB2 does not trip, then suspect:

1. A short on the +12 Volt line. This could be a cabling short or a failure on one of the boards. Use the Overall wiring diagram and individual board sections to trace the problem.
2. Defective filter capacitor C7, or
3. Defective bleeder resistor R7.

6.8.4 Servo Supply Breaker (CB6) Trips

If CB6 trips when CB1 is set to the on position:

a. Turn off A/C power.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

b. Disconnect wires 190, 191, and 192 from CR49 and CR48.

c. Turn the transmitter back on.

d. If CB6 trips, then suspect:

1. Rectifier, CR49 or CR48
2. Transformer T7, or
3. A weak CB6.

e. If CB6 does not trip, then suspect:

1. A short on the +24VDC, +20VDC, or -20VDC line. This could be a cabling short or a failure on one of the bandswitched circuits or servo assemblies. Use the Overall wiring diagram and individual board sections to trace the problem.
2. Defective filter capacitor C18, C19, or C20.

6.8.5 Supply Missing

If one or more of the supplies are missing on the Control Multimeter, check TB3 in the Power Supply Cabinet terminals 1 through 11, for the following voltages:

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

TB3-1 +22
TB3-2 -22
TB3-3 +8
TB3-4 -8
TB3-5 +12
TB3-6 B+
TB3-7 B-
TB3-8 Ground
TB3-9 +24
TB3-10 +20
TB3-11 -20

If these voltages are all present then check interconnect cabling and the Power distribution boards for an open. Refer to the Overall wiring diagram as needed.

If all of these voltages are missing:

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Check for 240VAC on the Primary of T6 by connecting test leads to T6 and routing those leads outside the transmitter to a voltmeter. Be sure to replace the cover before turning on any voltage.

1. If there is no voltage on T6, remove the test leads and check CB4 and CB1 for an open.
2. If there is voltage on the primary of T6, and one or more of the voltages are missing, check the following components associated with that supply:

+-22 CR43, C9, C10, T6
+-8 CR45, C13, C1, T6
B-B+ CR44, C10, C11, T6
+12 CR46, C7, T5

6.8.6 Distortion

The areas of the transmitter that have an effect on distortion are:

a. Output Network Tuning
b. RF Amp failures (missing steps)
c. Analog Input Board
d. Driver Encoder (A/D Phasing)
e. A to D Converter (spikes, spurious pulses) and,
f. Modulation Encoders (missing steps).

Refer to the Installation Section for Optimizing Tuning for Best distortion and the alignment or Troubleshooting sections of the individual boards as needed.

A suggested order to check the sections is

a. RF Amp Failures
b. Output Network Tuning
c. A/D Converter Phasing
d. Analog Input
e. Modulation Encoders, and
f. A/D converter

6.9 Measuring RF Drive Level And Phase

The following procedures will be referred to from other parts of the Troubleshooting section and from other sections in this manual.

6.9.1 Measuring RF Drive Level

Remember that there are two sections of each RF Amplifier and each will have an individual drive signal applied to the input.

NOTE

When measuring RF Amplifier drive amplitude, the amplifier to be measured must be turned "ON" to give a correct drive measurement. The drive waveform of an "OFF" amplifier will be below 0.0VDC and the peaks will probably be clipped. LED indicators DS3 will illuminate GREEN when an amplifier is on and drive level is at an adequate level.

NOTE

For maximum protection of personnel it is recommended to use the scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 24Vp-p, and ensure that the scope case is properly grounded.
b. Connect the ground clip of the probe to the edge of the inner front door of the transmitter nearest to the RF Amplifier being measured.
c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch the ungrounded end of CR3 (left side) which is located in front of the heatsink.
d. Make the measurement while holding the scope probe tip on CR3 and be careful not to touch other parts of the circuit.
e. Make the same measurement on the ungrounded end of CR4 (left side).

6.9.2 Measuring RF Drive Phasing

Remember that there are two sections of each RF Amplifier module and each section has an individual drive signal fed into it. Measure the RF Drive Phase using the same procedure and precautions as above.

a. Scope Setup - set the scope on DC coupled, 5V per division and the trace is at center of the screen. Connect the external sync of the scope to J5 on the Synthesizer Interface board and make sure the scope sync is set to External. Adjust the horizontal vernier on the scope so that one full RF cycle occupies 7.2 divisions on the screen. Each division now equals 50 degrees of phase shift. Using the Horizontal positioning and triggering level on the scope place the zero crossing of the waveform on the center crossing of the vertical and horizontal lines of the scope. Increase the vertical sensitivity of the scope to expand the waveform. Switch the scope to the X10 position and readjust the horizontal position so that the RF transition again crosses the center line of the scope. This will be the reference for the phase measurements. If another RF Amp transition occurs at the first large division on the left, this amplifier is operating at 5 degrees lagging from the reference.
b. Now that a reference phase has been established, without changing any of the scope settings, move the scope probe to the desired RF Amp to be measured. It is usually a good idea to first measure the drive phase of the Steps 1-6A then set your reference phase to the module that is typical of the six. There may be 4 modules operating at near the same phase and the other two may a few degrees off.
c. Again set the reference to the most common phase. Also note that there will be some phase difference between the A side and B side of the same module, but typically the A sides of the RF Amps should all line up as well as all the B sides should be within specifications. Typically there may be 2 to 4 degrees difference between A and B sides and there should be no more than +/-4 degrees difference between all the A sides when referenced to an A side. +/-4 degrees is also maximum phase difference between B sides when referenced to a B side. Also keep the ground lead of the probe close to the RF Amplifier being measured.

6.10 Measuring RF Drain Waveform And Phase

6.10.1 Measuring RF Drain Waveform

Remember that there are two sections of each RF Amplifier and each will have an individual drain signal at the output.

WARNING: Disconnect primary power prior to servicing.

NOTE

When measuring RF Amplifier drain waveform, the amplifier to be measured must be turned "ON" to give a correct measurement. There will be no drain waveform from an "OFF" amplifier. LED indicators DS3 will illuminate GREEN when an amplifier is on.

NOTE

For maximum protection of personnel it is recommended to use the scope probe (610-1131-000) or equivalent X10 scope probe to access this point since the long tip will reach through the air slots in the inner door.

a. Connect the probe to the scope set up to measure an RF waveform at approximately 230Vp-p, and ensure that the scope case is properly grounded.

b. Connect the ground clip of the probe to the edge of the inner front door of the transmitter nearest to the RF Amplifier being measured.

c. With the insulated extended tip securely fastened to the X10 scope probe, insert the tip of the probe through the rectangular cutout and touch TP1 which is located in front of the heatsink.

d. Make the measurement while holding the scope probe tip on TP1 and be careful not to touch other parts of the circuit.

e. Make the same measurement on TP2.

6.10.2 Measuring RF Drain Phasing

Remember that there are two sections of each RF Amplifier module and each has an individual drive signal fed into it. Measure the RF Drain Phase using the same procedure and precautions as above.

a. Scope Setup - set the scope on AC coupled, 50V per division, and the trace is centered on the screen.

b. Measure RF Drain Phase using the same procedure found in paragraph "Measuring RF Drive Phasing" in this section.

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

6.1 Introduction

The following section is intended to make the maintenance personnel aware of some of the bypass modes of operation that are possible in the transmitter. If certain failures occur, it is possible to temporarily bypass the source of the problem and remain operational at the highest possible power level until proper maintenance can be performed.

6.2 RF System Bypassing

6.2.1 Synthesizer Interface Failure

6.2.1.1 Optional Synthesizer Interface Installed

If the transmitter is equipped with optional Synthesizer Interface B A3, select B by moving S2 on the RF Interface to the B position or providing the correct control input.

6.2.1.2 Optional Synthesizer Interface Not Installed

On the Synthesizer Interface board, it is possible to bypass the Synthesizer.

6.2.1.2.1 External RF Input

If the Synthesizer fails, it is possible of feed in an External RF Input. Two jumpers will have to be moved, before the BNC connection is made:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.
b. Move JP2 from the Internal position of 1-2 to the External position of 2-3.
c. Ensure that JP3 is in the correct position for the source impedance used. JP3 2-3 for a 4.0-4.5 VP-P TTL level input or JP3 2-1 for 0-50 dBm 50 Ohm input.

6.2.2 Buffer/Predriver Failure

The transmitter is equipped with two Buffer/Predriver Amplifiers. Normally Buffer/Predriver A is selected for operation.

6.2.2.1 Select Buffer/Predriver B

To select Buffer/Predriver Amplifier B move S1 on the Driver Encoder A7 to the B position or provide the correct control input.

6.2.3 Driver Amplifier Failure

6.2.3.1 Multiple Driver Failures

If the operation of the AGC circuit is not sufficient to maintain the proper RF drive level, the transmitter will turn OFF due to a Low Drive Fault. After using the Troubleshooting Section to determine the location of the failed Drivers it is possible to:

WARNING

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6.2.3.2 Change RF Amplifier/Driver Positions

They can be manually switched with the highest Big Step RF Amplifiers. RF156 should be used first, RF155 second, and so on.

6.2.4 Big Step RF Amplifier Failure

FLEXPATCH

Flexpatch is a method of substituting a failed Big Step RF Amplifier's turn on/off control line with one of the Programmable Big Steps. There are five Programmable Big Steps in the transmitter, their locations are:

a. Left Compartment, the bottom left and right amplifier slots. Normally programmed to be Big Steps RF 152(L) by Modulation Encoder A29 and RF153(R) by Modulation Encoder A28.
b. Center Compartment, the bottom left and right amplifier slots. Normally programmed to be Big Steps RF 154(L) by Modulation Encoder A27 and RF155(R) by Modulation Encoder A26.
c. Right Compartment, the bottom right amplifier slot. Normally programmed to be Big Step RF156(R) by Modulation Encoder A25.

These Programmable Steps are the five highest steps in the transmitter. If they are substituted for lower steps, only a reduction in positive peak modulation will occur.

To substitute a failed step, the gold jumper for the step will have to be removed and the switch positions on S7 and S8 will have to be reset on the appropriate Modulation Encoder.

USING FLEXPATCH

a. Example 1 - Step 9 has failed.

   The Modulation Encoder for this step is A29 (SEE VIEWS 14 & 21A for the following discussion).

   1. The gold jumper for Step 9 is P3-7, as shown on the right side of P3. Carefully remove this jumper.
   2. Using the FLEXCODE chart, rotate S7 from 8 to 9 and rotate S8 from 9 to 0.
   3. Now the Step that was RF152 is effectively Step 9.

b. Example 2 - Step 133 has failed.

   The Modulation Encoder for this step is A25 (SEE VIEWS 10 & 23 for the following discussion).

   1. The gold jumper for Step 133 is P1B-8, as shown on the right side of P1B. Carefully remove this jumper.

WARNING: Disconnect primary power prior to servicing.

2. Using the FLEXCODE chart, rotate S7 from 12 to 5 and rotate S8 from 9 to 8.
3. Now the Step that was RF156 is effectively Step 133.

6.3 Audio/Digital Modulation System Bypassing

6.3.1 Analog Input Bypassing

On the Analog Input board, three types of bypassing are possible without compromising transmitter protection. They are as follows:

6.3.1.1 Power Control

If it has been determined that the HIGH, MED, and LOW power level control is not operating properly, a fourth Bypass Power Level control can be made operational as follows:

a. Apply an RF Mute with S1 on the Controller and turn the transmitter on HIGH.
b. Move P4 from the Normal position of 2-3 to the Bypass position of 2-1.
c. Turn R68 Bypass Power Level fully counterclockwise.
d. Remove the RF Mute and adjust R68 to the desired power level.

NOTE

R68 can adjust the power level from 10 to 100 kW. If the power level needs to be changed while in the Bypass mode, it must be done manually by adjusting R68.

CAUTION

DO NOT SWITCH TO THE MEDIUM OR LOW POWER LEVELS - THE MODULATION MONITOR SAMPLE WILL BE MUCH HIGHER AND COULD POSSIBLY DAMAGE SOME EQUIPMENT.

6.3.1.2 Fine Power Control

If it has been determined that the Fine Power Control is not operating properly, it can be bypassed as follows:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.
b. Move P6 from the Normal position of 2-3 to the Bypass position of 2-1.
c. Turn on the transmitter at the desired power level.

NOTE

To make fine adjustments to the power level, use R66 for LOW, R67 for MED, and R65 for HIGH.

6.3.1.3 Correction

If it has been determined that the Correction signal is causing transmitter problems, it can be bypassed as follows:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.
b. Move P5 from the Normal position of 2-1 to the Bypass position of 2-3.
c. Turn on the transmitter at the desired power level.

NOTE

It may be necessary on adjustments to readjust the power level with the Raise/Lower control.

6.3.2 Modulation Encoder Bypass

If a Modulation Encoder has generated a Supply Fault that has turned off the transmitter, it is possible to bypass the encoder and operate at a lower power level. The amount of power reduction depends upon the failed encoder.

After using the Troubleshooting Section to determine the location of the encoder to bypass:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.
b. Move the jumper plug on the encoder from the Normal position J13 and place it in the Bypass position J12.

NOTE

To remove the jumper, grasp the ends while pressing on the outside tabs and pull the jumper straight out. To reinstall the jumper, simply align and press straight in until the tabs click when properly seated.

c. Turn on the Main Breaker again, and operate the transmitter at the reduced power level.

NOTE

Only one Modulation Encoder may be bypassed at any time.

The following is a list of the maximum power level obtainable at 100 % modulation for the following encoders when bypassed:

a. A25 - 90kW
b. A26 - 52kW
c. A27 - 24kW
d. A28 - 5kW

NOTE

If the A29 Encoder has failed, it is still possible to bypass the board and run full power with a lower level of modulation to prevent distortion.

6.3.3 Changing Modulation Encoder ROM'S

If one of the A29,28,or A27 encoders has failed, it is possible to bypass the board and move it's ROM determining jumpers to the A26 encoder. This will make the A26 encoder control the steps of the bypassed encoder and allow the highest level of carrier power and modulation.

The maximum power level obtainable at 100 % modulation when the A29, A28, or A27 Modulation Encoder is bypassed is 52kW.

Use the following procedure:

a. Turn off the Main Breaker for the Low Voltage Power Supplies.
b. Carefully remove JP1, JP2, JP4, and JP5 from the A26 Modulation Encoder. These dip jumper plugs are labeled ME13, ME14, ME15, and ME16.

NOTE

Use an IC extraction tool or a small screwdriver to carefully pull the plug straight out of the socket without bending any of the leads.

WARNING: Disconnect primary power prior to servicing.

6.3.3.1 A29 Bypass And ROM Switching

a. Bypass the encoder using the procedure described earlier.

b. Carefully remove JP1, JP2, JP4, and JP5 from the A29 Modulation Encoder. These dip jumper plugs are labeled ME1, ME2, ME3, and ME4.

NOTE

Carefully align pin 1 of the jumper to pin 1 of the socket and ensure the rest of the pins are in the correct position. Push the jumper straight into the socket until all pins are seated into the socket.

c. On the A26 encoder:
   1. Install ME1 into JP1
   2. Install ME2 into JP4
   3. Install ME3 into JP5
   4. Install ME4 into JP2

d. On the A29 encoder:
   1. Install ME13 into JP2
   2. Install ME14 into JP5
   3. Install ME15 into JP4
   4. Install ME16 into JP1

e. RF Amplifiers RF94 through RF124 are now actually turning on for steps RF1 through RF31.

6.3.3.2 A28 Bypass And ROM Switching

a. Bypass the encoder using the procedure described earlier.

b. Carefully remove JP1, JP2, JP4, and JP5 from the A28 Modulation Encoder. These dip jumper plugs are labeled ME5, ME6, ME7, and ME8.

NOTE

Carefully align pin 1 of the jumper to pin 1 of the socket and ensure the rest of the pins are in the correct position. Push the jumper straight into the socket until all pins are seated into the socket.

c. On the A26 encoder:
   1. Install ME5 into JP1
   2. Install ME6 into JP4
   3. Install ME7 into JP5
   4. Install ME8 into JP2

d. On the A28 encoder:
   1. Install ME13 into JP1
   2. Install ME14 into JP4
   3. Install ME15 into JP5
   4. Install ME16 into JP2

e. RF Amplifiers RF94 through RF124 are now actually turning on for steps RF32 through RF62.

6.3.3.3 A27 Bypass And ROM Switching

a. Bypass the encoder using the procedure described earlier.

b. Carefully remove JP1, JP2, JP4, and JP5 from the A27 Modulation Encoder. These dip jumper plugs are labeled ME9, ME10, ME11, and ME12.

NOTE

Carefully align pin 1 of the jumper to pin 1 of the socket and ensure the rest of the pins are in the correct position. Push the jumper straight into the socket until all pins are seated into the socket.

c. On the A26 encoder:
   1. Install ME9 into JP1
   2. Install ME10 into JP4
   3. Install ME11 into JP5
   4. Install ME12 into JP2

d. On the A27 encoder:
   1. Install ME13 into JP2
   2. Install ME14 into JP5
   3. Install ME15 into JP4
   4. Install ME16 into JP1

e. RF Amplifiers RF94 through RF124 are now actually turning on for steps RF63 through RF93.

6.4 Frequency Control Bypassing

6.4.1 Frequency Control Interface

6.4.1.1 Bandswitch Bypassing

If it has been determined that the output of an encoder PAL on the Frequency Control Interface board is incorrect, it is possible to manually program the input to the relay drivers.

a. With the transmitter turned OFF, remove the gold jumper plug that is connected to the relay driver input at J6,7,8,10, or 11.
   1. If the PAL output should be logic low (relay on) but is not, connect the input to the relay driver to ground at any one of the number 8 or number 9 pins of J6,7,8,10, or 11.
   2. If the PAL output should be logic high (relay off) but is not, connect the input to the relay driver to +5Vdc at any one of the number 7 or number 10 pins of J6,7,8,10, or 11.

b. Turn on the transmitter and retune as needed at very low power levels, progressively increasing to full power.

6.4.2 Servo Bypassing

If it has been determined that one of the Reference voltages for a servo is incorrect, it is possible to manually adjust the servo.

a. With the transmitter turned OFF, place JP3 or JP2 to the Bypass position.

b. The servo can be manually tuned with the Bypass Reference Adjustment, using the Position voltage as the new Reference voltage for the selected frequency.

c. Turn on the transmitter and retune as needed at very low power levels, progressively increasing to full power.

NOTE

Only slight adjustments should be made to the pot for fine tuning.

WARNING: Disconnect primary power prior to servicing.

6.4.3 Driver Encoder Bypassing

If it has been determined that the output of an encoder PAL on the Driver Encoder is incorrect, it is possible to manually program the input to the Driver.

a. With the transmitter turned OFF, remove the gold jumper plug that is connected to the inverter input at JP2 or JP3.

1. If the PAL output should be logic low (Driver off) but is not, connect the input to the inverter to ground.
2. If the PAL output should be logic high (Driver on) but is not, connect the input to the relay driver to +5Vdc at JP3-1 or JP3-16.

WARNING: Disconnect primary power prior to servicing.

SECTION VII
PARTS LIST

Replaceable Parts List Index

Table 7-1.	XMTR DX100-3F MW	994 9369 103 (F)	7-3
Table 7-2.	POWER AMPLIFIER CABINET	992 8518 002 (D)	7-3
Table 7-3.	PWA, IPA PWR SPLITTER,ESD SAFE	992 5889 002 (D)	7-8
Table 7-4.	PWA, MULTIMETER/PROBE,ESD SAFE	992 6752 005 (B)	7-9
Table 7-5.	*PWA, DX SWITCH,	992 6784 002 (J)	7-9
Table 7-6.	PWA, FUSE, ESD SAFE	992 8007 003 (F)	7-10
Table 7-7.	PWA, FUSE, ESD SAFE	992 8007 004 (G)	7-10
Table 7-8.	RF AMPLIFIER MODULE	992 8179 001 (L)	7-11
Table 7-9.	PWA, PWR DISTRIBUTION,ESD SAFE	992 8187 001 (B)	7-12
Table 7-10.	LED BD	992 8188 001 (J)	7-12
Table 7-11.	CONTROLLER BD	992 8189 001 (Y)	7-13
Table 7-12.	PWA, A/D BOARD	992 8191 003 (M)	7-15
Table 7-13.	MOD ENCODER BD	992 8193 001 (AC)	7-17
Table 7-14.	MOD ENCODER BD/BINARY	992 8193 002 (AB)	7-20
Table 7-15.	BUFFER AMP BD	992 8196 001 (J)	7-23
Table 7-16.	PWA, RF SPLITTER, ESD SAFE	992 8201 001 (B)	7-24
Table 7-17.	PAC CABLE PKG FA	992 8354 002 (N)	7-24
Table 7-18.	AIR FLOW MONITOR	992 8363 001 (H)	7-24
Table 7-19.	PWA, DRIVER MOTHERBD, ESD SAFE	992 8538 001 (U)	7-25
Table 7-20.	EFFICIENCY COIL OCTAL,ESD SAFE	992 8539 002 (E1)	7-26
Table 7-21.	EFFICIENCY COIL OCTAL,ESD SAFE	992 8539 003 (B)	7-26
Table 7-22.	PWA, MAIN MOTHERBD, ESD SAFE	992 8548 001 (R)	7-26
Table 7-23.	PWA, BINARY MOTHERBD, ESD SAFE	992 8549 001 (N)	7-27
Table 7-24.	PRE DRIVER TUNING BD,	992 8604 001 (E2)	7-28
Table 7-25.	DRIVER TUNING ASSY	992 8605 002 (A)	7-28
Table 7-26.	ANALOG INPUT BD.	992 8882 001 (T)	7-29
Table 7-27.	OUTPUT NETWORK CABINET	992 8519 002 (C)	7-32
Table 7-28.	RIBBON CABLES, ONC	943 5155 812 (B1)	7-35
Table 7-29.	CABLE ONC 100KW FA	952 9180 009 (S3)	7-35
Table 7-30.	PWA, OUTPUT SAMPLE, ESD SAFE	992 8203 001 (M)	7-36
Table 7-31.	CAPACITOR SERVO DRIVE	992 8551 001 (H)	7-37
Table 7-32.	INDUCTOR SERVO DRIVE	992 8552 001 (G)	7-37
Table 7-33.	MOTORIZED SWITCH	992 8555 001 (H)	7-38
Table 7-34.	PWA, ARC DETECTOR	992 8677 001 (E)	7-38
Table 7-35.	POWER SUPPLY CABINET	992 8520 002 (B)	7-39
Table 7-36.	POWER SUPPLY DISCHARGE	992 8684 002 (H)	7-42
Table 7-37.	UNIQUE PARTS 100-3F	992 8585 004 (F)	7-42
Table 7-38.	PAINTED PLUG BUTTON	917 2150 605 (A)	7-43
Table 7-39.	PSC/PAC PLATE	922 0999 585 (A)	7-43
Table 7-40.	CLOSEOUT PLATE	922 0999 623 (A)	7-43
Table 7-41.	PAC METER/DISPLAY PNL	943 5155 091 (D)	7-43
Table 7-42.	VIEW LOCATION PLATE	943 5155 691 (A)	7-44
Table 7-43.	CABLE, SHUNT METER	943 5155 804 (A)	7-44
Table 7-44.	PANEL, 3 FREQUENCY CONTROL	943 5523 981 (A)	7-44
Table 7-45.	CABLE, FA100 PWR DIST	952 9180 505 (J3)	7-44
Table 7-46.	CABLE PAC R-DOOR AC DIST.	952 9180 509 (B1)	7-45
Table 7-47.	FREQUENCY CONTROL BD	992 8525 003 (B)	7-45
Table 7-48.	FREQ CTRL INTFC BD	992 8526 003 (A)	7-47

WARNING: Disconnect primary power prior to servicing.

Table 7-49.	DRIVER ENCODER BD,	992 8537 005 (A)	7-50
Table 7-50.	XMTR INTERFACE BD,	992 8540 003 (A)	7-52
Table 7-51.	SYNTHESIZER INTERFACE BD	992 8588 001 (R)	7-53
Table 7-52.	RF INTERFACE BD,	992 8629 001 (G)	7-55
Table 7-53.	EXTERNAL INTERFACE BD,	992 8631 001 (G)	7-56
Table 7-54.	POWER SUPPLY INTERFACE	992 8643 001 (F)	7-57
Table 7-55.	PWA, DX100-3F CONTROLLER	992 9511 588 (B)	7-58
Table 7-56.	PWA, 3 FREQ SELECT	992 9764 500 (A)	7-58
Table 7-57.	INSTALLATION KIT	992 8642 002 (B)	7-59
Table 7-58.	AIR FILTER SET	994 9511 001 (B)	7-59

Table 7-1. XMTR DX100-3F MW - 994 9369 103 (F)

Harris PN	Description	QTY	UM	Reference Designators
646 1662 015	NAMEPLATE, DX100	1		PRODUCT LINE IS OK WITH STANDARD DX100 NAMEPLATE
646 1662 030	NAMEPLATE, HARRIS	1		
988 2339 002	DP, DX100-3F XMTR	0		
992 8518 002	POWER AMPLIFIER CABINET	1	EA	
992 8519 002	OUTPUT NETWORK CABINET	1	EA	
992 8520 002	POWER SUPPLY CABINET	1	EA	
992 8585 004	UNIQUE PARTS 100-3F	1	EA	
992 8642 002	INSTALLATION KIT	1	EA	
994 9511 001	AIR FILTER SET	0	EA	

Table 7-2. POWER AMPLIFIER CABINET - 992 8518 002 (D)

Harris PN	Description	QTY	UM	Reference Designators
007 4030 023	BRZ, PH GND BAR 97-744-05	90	EA	
041 1310 025	RUB SILICONE SPONGE	1.575	RL	
041 6030 014	CHANNEL 1/16 MTL	10.5	FT	
200000000000001733	SPACER, OUTPUT MONITOR PWB	2	EA	
200000000000001734	SPACER, OUTPUT MONITOR PWB	2	EA	
302 0401 000	SCR, 4-40 X 1/4	44	EA	
302 0411 000	SCR, 6-32 X 3/8	150	EA	
302 0551 000	SCR, SOC HD SHOULDER	3	EA	
302 0693 000	SCREW, 1/4-28 X .625	18	EA	
302 0713 000	SCR, 5/16-18 X .75 LG	44	EA	
302 0722 000	SCR, 10-32 X 1	12	EA	
302 0723 000	SCREW, 6-32 X 1	33	EA	
328 0070 000	WASHER CUPPED BLACK WEAR	27	EA	
328 0073 000	WASHER, RETAINER	27	EA	
336 1137 000	PIN, SPRING	6	EA	
350 0157 000	RIVET 3/16 ALUM .251/.375	4	EA	
354 0624 000	TERMINAL, MALE	12	EA	
354 0625 000	TERMINAL, FEMALE	12	EA	
358 0002 000	*BRACKET RESISTOR MTG	2	EA	#R002
358 0437 000	BUSHING PANEL .252 ID	1	EA	
358 0960 000	CPLR, 1/4"X1/4" SHAFT	1	EA	
358 1214 000	SCREWLOCK, FEMALE	1	EA	#A054
358 2401 000	STANDOFF, HINGED 1/4 OD	2	EA	2#A1
358 2511 000	STANDOFF, 10-32 X 3/4	42	EA	
358 2628 000	CABLE PUSH MOUNT	7	EA	
358 2995 000	END PLATE, 261 TERM BD	1	EA	#TB004
358 3095 000	STUD, BRS 6-32 X 3/4	32	EA	
358 3110 000	STUD, BRS 8-32 X 1-1/4	2	EA	#R005
358 3122 000	STUD, BRS 10-32 X 1-1/4	45	EA	
358 3131 000	STUD, BRS 1/4-20 X 1	3	EA	#C004 2#A008
358 3171 000	STUD 1/4 TURN PHILLPS HD	12	EA	
358 3325 000	STUD 1/4 TURN PHILLIPS HD	15	EA	
358 3370 000	STDOFF 1/4 HEX X 1.0 LG	72	EA	
384 0694 000	LED RED CART 12V	4	EA	DS001,DS002,DS003,DS004
398 0186 000	FUSE 1 TIME 30A 250V	2	EA	F001,F002
398 0471 000	FUSE, TIME-DELAY, 1.5 AMP 500V	27	EA	A43F001,A43F002,A43F003,A43F004,A43F005,A43F006,A43F007,A43F008,A43F009,A44F001,A44F002,A44F003,A44F004,A44F005,A44F006,A44F007,A44F008,A44F009,A45F001,A45F002,A45F003,A45F004,A45F005,A45F006,A45F007,A45F008,A45F009

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402 0014 000	FUSE HOLDER, 2 POLE	1	EA	XF1-2
402 0130 000	FUSE HOLDER, 3 POLE	9	EA	A43XF1-XF9 A44XF1-XF9 A45XF1-XF9
410 0008 000	INSULATOR ROUND NS5W 0205	2	EA	#R005
424 0001 000	GROMMET 3/8 MTG DIA	1	EA	
424 0023 000	GROMMET 1 IN MTG DIA	10.00	EA	
424 0055 000	BUMPER RUBBER 3/8" ID	4	EA	
424 0602 000	GROMMET 1-1/4 MTG DIA	7	EA	
430 0217 000	FAN BLADE,16" 20DEG PITCH	9	EA	
430 0221 000	*FAN GUARD 17.3 DIA	9	EA	
436 0294 000	MOTOR 1/2 HP 50/60 HZ 3PH	9	EA	
448 0884 000	LATCH, FLUSH, LIFT & TURN	3	EA	
448 0957 000	HINGE DOOR POSITIONING	12	EA	
448 0959 000	FILTER, AIR	27	EA	
456 0144 000	SPRING, EJECTOR	27	EA	
492 0309 000	INDUCTOR VAR 28UH	1	EA	L001
494 0424 000	CHOKE RF 8.8UH	1	EA	T004
504 0439 000	CAP 9100PF 8KV 5% (293)	8	EA	C001A,C001B,C001C,C001D,C001E,C001F,C001G,C001H
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	2	EA	C004,C005
524 0219 000	CAP 5500 UF 200V -10, +50%	3	EA	C006,C047,C048
524 0322 000	CAP 15000UF 100WVDC -10, +75%	1	EA	C008
524 0341 000	CAP 5100 UF 350WVDC -10, +50%	39	EA	C007,C009,C010,C011,C012,C013,C014,C015,C016,C017,C018,C019,C020,C021,C022,C023,C024,C025,C026,C027,C028,C029,C030,C031,C032,C033,C034,C035,C036,C037,C038,C039,C040,C041,C042,C043,C044,C045,C046
540 1600 018	RES 5.1 OHM 3W 5%	3	EA	R005A,R005B,R005C
540 1600 405	RES 15K OHM 3W 5%	2	EA	R047,R048
540 1600 422	RES 75K OHM 3W 5%	41	EA	R006,R007,R008,R009,R010,R011,R012,R013,R014,R015,R016,R017,R018,R019,R020,R021,R022,R023,R024,R025,R026,R027,R028,R029,R030,R031,R032,R033,R034,R035,R036,R037,R038,R039,R040,R041,R042,R043,R044,R045,R046
552 0085 000	RES, ADJ 50 OHM 50W	1	EA	R002
552 0173 000	RES, ADJ 10 OHM 175W	1	EA	R001
580 0009 000	RELAY, VACUUM, SPST	3	EA	K002,K003,K004
580 0010 000	RELAY, VAC SPDT 26.5VDC	1	EA	K001
604 1079 000	SW DPST 15A 125/250 VAC	6	EA	S001,S002,S003,S004,S005,S006
614 0056 000	TERM BD 12 TERM	2	EA	TB001,TB002
614 0718 000	JUMPER MODEL 601-J/141J	2	EA	
614 0786 000	TERM BD, 2C MODULAR 261	5	EA	TB004
620 0455 000	ADPT BNC UG492A/U	1	EA	J001
620 0573 000	CONN, ANCHOR INS 1-5/8	1	EA	
632 1133 000	AMMETER, 0-3ADC, 4.5",[W]	1		M001
632 1163 000	WATTMETER, 0-200KW, 4.5",[W]	1		M003
632 1164 000	AMMETER, 0-1000ADC, 4.5",[W]	1		M002
638 0028 000	SHUNT, METER 1000A 50MV	1		SH001
638 0029 000	SHUNT, METER 30A 250MV	1		SH002
646 0726 000	MARKER STRIP MS-6-141	1		#TB006
646 1250 000	LABEL SAFETY INSTR	3		
646 1253 000	*LABEL WARNING ROTATING BLADES	3		
646 1253 201	LABEL, WARNING	9		
646 1254 000	LABEL DANGER HI VOLTAGE	3		
646 1255 201	LABEL, WARNING	1		PLACE ON 939 7930 611 DRIVER MM HOUSING
646 1350 000	MARKER STRIP 12 TERM	2		#TB001,#TB002
646 1353 000	NAMEPLATE, XMTR EQUIPMENT	1		
650 0028 000	KNOB RD SKIRT 1.135" DIA	5		
813 4999 030	STDOFF 6-32X1.00 1/4 HEX	32		

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813 4999 031	STDOFF 6-32X1-1/4 1/4 HEX	55	
813 5000 030	STDOFF 8-32X1 5/16 HEX	4	
813 5007 041	STDOFF 6-32 X 1.63 X .25D	11	
813 5009 005	STDOFF .38 X .38RD X 6-32	12	USED TO MOUNT OUTPUT MONITOR
817 2150 001	STANDOFF	19	
817 2150 004	SHUNT TAPPING BAR	1	
817 2150 013	RT TOP CONTACT PLT	1	
817 2150 033	CONTACT PLT	16	
817 2150 034	CONTACT PLT	6	
817 2150 037	GROUNDING PLATE	3	
822 0922 018	SPLITTER INS SHT	2	
822 0922 027	MIDDLE RF COND	4	
822 0922 033	FRT DOOR HINGE PLATE	3	
822 0922 048	SWITCH PLUNGER	3	
822 0922 075	DOOR HINGE PIN	3	
822 0922 112	STDOFF 1 X 1 X 1/4-20	1	
822 0922 137	CLOSEOUT PLATE	3	
822 0922 150	RF SAMPLE PLATE	1	
822 0922 165	SHAFT 3.3"	1	#L002
822 0999 001	BINARY RF COND	1	
822 0999 002	BTM RF COND	3	
822 0999 003	MID RF COND	2	
822 0999 018	PAC/PSC DISPLAY TRIM	2	
822 0999 019	PAC METER TRIM	2	
822 0999 024	CABLE MTG CHANNEL	7	
822 0999 025	PAC BUS STDOFF	8	
822 0999 029	COMB COVER TOP MTG PLT	4	
822 0999 033	COND SUPPORT BAR	2	
822 0999 038	DOOR STOP ARM	6	
822 0999 040	DOOR STOP BLOCK	6	
822 0999 041	SHORTING SWITCH CVR	3	
822 0999 061	SWITCH PLUNGER	3	
822 0999 071	SHIELD 8.5 X 16.5	1	
822 0999 072	SHIELD 8.5 X 12.5	2	
822 0999 126	SWITCH SHIELD	3	
829 9009 142	CLIP, METER MTG	6	
829 9009 250	ADJUSTMENT COUPLING	1	
839 7855 021	STIFFENER	2	
839 7855 042	RF AMP ACCESS PNL HINGE	3	
839 7855 086	RF AMP ACCESS PNL HINGE	3	
839 7930 061	DRIVE CABLE SUPPORT	2	
839 7930 063	FUSE BD BUS BAR	2	
839 7930 064	TOP BUS BAR	1	
839 7930 072	AIR FLOW SENSOR DUCT	6	
839 7930 073	STIFFENER	1	
839 7930 074	STIFFENER	1	
839 7930 075	RF COND COVER	2	
839 7930 076	BTM RF COND COVER	2	
839 7930 077	BTM RT COND COVER	1	
839 7930 078	TOP RF COND COVER	2	
839 7930 079	MID RF COND COVER	2	
839 7930 080	RT TOP RF COND COVER	1	
839 7930 081	DRVR RF COND COVER	1	
839 7930 091	PAC CLOSEOUT PLT	1	
843 5155 161	DIAGRAM, DRV CBL INTRCONN	0	

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843 5155 162	DIAGRAM, MOD ENC FIRING	0		
917 2150 009	PLATE, BTM CONTACT	3	EA	
917 2150 029	TEMP SENSOR	1	EA	U001
917 2150 535	STANDOFF	44	EA	
917 2150 539	RES MTG BRACKET	2	EA	
917 2150 540	RES MTG PLUG	2	EA	
917 2150 541	THREADED ROD	1	EA	
917 2150 562	LT ACCESS PNL	1	EA	
917 2150 563	RT ACCESS PNL	1	EA	
917 2150 566	STANDOFF, SPLITTER	4	EA	
917 2150 596	STDOFF 0.75 X 1.25 X10-32	6	EA	
917 2150 599	CAP MTG PLATE	1	EA	#C004,C005
917 2150 797	STRAP 1.0 X 3.0 LG	1	EA	C49 #K4 TO
917 2150 798	STRAP, 1.0 X 6.0 LG	1	EA	#C49,C50 TO
917 2150 799	STRAP, 1.0 X 12.0 LG	1	EA	#RF COND GND PLATE TO K4
917 2558 079	PATENT LABEL- AM XMTRS	1	EA	
922 0922 046	SWITCH HOT PLATE ASSY	3	EA	
922 0922 047	SW SPRING CONTACT ASSY	3	EA	
922 0922 091	SWITCH MTG ANGLE	3	EA	
922 0922 161	TRANSFORMER	1	EA	T003
922 0922 212	INSULATION, DOOR 21 X 48	1	EA	
922 0922 213	INSULATION, DOOR 21 X 21	3	EA	
922 0922 214	INSULATION, DOOR 21 X 6	1	EA	
922 0999 016	Z BRACE	8	EA	
922 0999 039	DOOR STOP BRACE	6	EA	
922 0999 044	SHORTING SWITCH ASSY	3	EA	
922 0999 045	SHORTING SW CONTACT ASSY	3	EA	
922 0999 522	HINGE PLT	12	EA	
922 0999 570	MODULE STOP BAR	10	EA	
922 0999 571	MODULE STOP BAR 1	1	EA	
922 0999 572	MODULE STOP BAR 2	1	EA	
922 0999 576	OUTPUT CROSSOVER COND	1	EA	
922 0999 581	ONC/PAC PLATE	1	EA	
922 0999 591	CTR CONDUCTOR	1	EA	
922 0999 603	PAC/PSC DISPLAY TRIM	2	EA	
922 0999 605	TRANSFORMER	1	EA	
922 0999 606	BOOST XFMR	1	EA	
922 0999 607	DRVR RF CONDUCTOR	1	EA	
922 0999 620	BRK'T, STRAIN RELIEF	4	EA	
922 0999 622	RING, DRIVE CABLE SUPPORT	1	EA	
922 0999 641	TERMINAL COVER	2	EA	#TB001,#TB002
922 0999 643	ENTRY COVER PLATE	1	EA	
922 0999 697	RELAY MTG BRKT	1	EA	XK004
922 0999 723	STRAP	2	EA	K002 RF COND -
922 0999 724	STRAP	2	EA	K003 RF COND -
922 0999 725	STRAP	4	EA	(2) K2-C2 (2) K3-C3
922 1238 391	STANDOFF, DOOR LATCH STOP	2	EA	
922 1238 512	SHIELD, 8.5 X 11.5	1	EA	
939 7930 067	FUSE BD BUS BAR	1	EA	
939 7930 087	CAP MTG PLT	2	EA	#C001,C002,C003
939 7930 588	CAP MTG BRACKET	20	EA	
939 7930 592	PAC CAP BRACKET	1	EA	
939 7930 603	OUTER COND ASSY	1	EA	
939 7930 611	DRVR MM HOUSING	1	EA	
939 7930 615	CROSSOVER COVER	1	EA	

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939 7930 616	PA CROSSOVER COND	1	EA	
939 7930 617	PAC INNER PNL ANG FRT	2	EA	
939 7930 618	TOP CROSSOVER COND	1	EA	
939 7930 619	CROSSOVER DUCT	3	EA	
939 7930 620	DRIVE CABLE SUPPORT CHNL	1	EA	
939 7930 621	PAC CAP RF SHLD	2	EA	
939 7930 623	PAC INNER PNL ANG REAR	2	EA	
939 7930 624	BASE RBN SHLD	3	EA	
939 7930 625	UPPER RBN CBL SHIELD	3	EA	
939 7930 626	RBN CBL SHIELD	2	EA	
939 7930 627	RBN CBL SHIELD	5	EA	
939 7930 628	RBN CBL SHIELD	2	EA	
939 7930 629	LOWER CBL SHIELD	5	EA	
939 7930 660	HANDLE, ACCESS PNL RF AMP	3	EA	
939 7930 662	RT OUTER PNL RBN SHLD	1	EA	
939 7930 663	LT INNER PNL RT RBN SHLD	1	EA	
939 7930 664	LT OUTER PNL RBN SHLD	1	EA	
939 7930 665	RT INNER PNL RT RBN SHLD	1	EA	
939 7930 666	BOTTOM POS BUS BAR	1	EA	
939 7930 680	RF COND GND PLT	1	EA	
939 7930 681	CAP BRKT	1	EA	#C1D E
939 7930 682	CAP BRKT	1	EA	#C1A B C
943 5155 112	RT COMBINER SUPPORT	1	EA	
943 5155 114	RT COMBINER SUPPORT	1	EA	
943 5155 572	PAC DOOR COVER ASSY	3	EA	
943 5155 574	PAC REAR DOOR	3	EA	
943 5155 602	PWR AMP CAB	1	EA	
943 5155 603	PAC TOP	1	EA	
943 5155 604	RT COMBINER FRT SUPPORT	1	EA	
943 5155 605	LT COMBINER FRT SUPPORT	1	EA	
943 5155 606	PAC BASE SHIELD	1	EA	
943 5155 607	PAC LT OUTER PNL	1	EA	
943 5155 608	PAC RT OUTER PNL	1	EA	
943 5155 609	PAC LT INNER PNL	1	EA	
943 5155 610	PAC RT INNER PNL	1	EA	
943 5155 611	PAC CTR FRONT DOOR	1	EA	
943 5155 612	PAC RT FRONT DOOR	1	EA	
943 5155 613	RF AMP ACCESS PNL	1	EA	
943 5155 627	LT COMBINER FRT SUPPORT	2	EA	
943 5155 628	RT COMBINER FRT SUPPORT	2	EA	
943 5155 630	RT FRT DOOR SHIELD	1	EA	
943 5155 631	CTR FRT DOOR SHIELD	1	EA	
943 5155 640	PAC LT FRONT DOOR	1	EA	
943 5155 643	BOTTOM DRVR SHELF	1	EA	
943 5155 656	PREDRIVER TUNE MTG PLT	1	EA	
943 5155 659	SHIELD, FRT PA CROSSOVER	1	EA	
943 5155 660	REAR PA CROSSOVER SHIELD	1	EA	
943 5155 661	LT COMBINER SUPPORT	1	EA	
943 5155 662	FRT OUTPUT XOVER COVER	1	EA	
943 5155 663	REAR OUTPUT XOVER COVER	1	EA	
943 5155 664	LT COMBINER SUPPORT	1	EA	
943 5155 665	RT COMBINER SUPPORT	1	EA	
943 5155 666	LT COMBINER SUPPORT	1	EA	
943 5155 667	LT COMBINER SUPPORT	1	EA	
943 5155 668	RT COMBINER SUPPORT	1	EA	

WARNING: Disconnect primary power prior to servicing.

943 5155 669	TOP DRVR SHELF	1	EA	
943 5155 698	SPLITTER DECK	1	EA	
943 5155 828	SHIELD, LEFT FRONT DOOR, PAC	1.0	EA	
943 5450 357	DRIVER DRIVE CABLE	4	EA	
943 5450 469	RF DRIVE CABLE	20	EA	
992 5889 002	PWA, IPA PWR SPLITTER,ESD SAFE	1	EA	A046
992 6752 005	PWA, MULTIMETER/PROBE,ESD SAFE	2	EA	A009,A041
992 6784 002	*PWA, DX SWITCH,	1	EA	A035
992 8007 003	PWA, FUSE, ESD SAFE	1	EA	A036
992 8007 004	PWA, FUSE, ESD SAFE	4	EA	A037,A038,A039,A040
992 8179 001	RF AMPLIFIER MODULE	175	EA	RF,RF001,RF002,RF003,RF004,RF005,RF006,RF007,RF008,RF009,RF010,RF011,RF012,RF013,RF014,RF015,RF016,RF017,RF018,RF019,RF020,RF021,RF022,RF023,RF024,RF025,RF026,RF027,RF028,RF029,RF030,RF031,RF032,RF033,RF034,RF035,RF036,RF037,RF038,RF039,RF040,RF041,RF042,RF043,RF044,RF045,RF046,RF047,RF048,RF049,RF050,RF051,RF052,RF053,RF054,RF055,RF056,RF057,RF058,RF059,RF060,RF061,RF062,RF063,RF064,RF065,RF066,RF067,RF068,RF069,RF070,RF071,RF072,RF073,RF074,RF075,RF076,RF077,RF078,RF079,RF080,RF081,RF082,RF083,RF084,RF085,RF086,RF087,RF088,RF089,RF090,RF091,RF092,RF093,RF094,RF095,RF096,RF097,RF098,RF099,RF100,RF101,RF102,RF103,RF104,RF105,RF106,RF107,RF108,RF109,RF110,RF111,RF112,RF113,RF114,RF115,RF116,RF117,RF118,RF119,RF120,RF121,RF122,RF123,RF124,RF125,RF126,RF127,RF128,RF129,RF130,RF131,RF132,RF133
992 8187 001	PWA, PWR DISTRIBUTION,ESD SAFE	3	EA	A033,A034,A052
992 8188 001	LED BD	1	EA	A042
992 8189 001	CONTROLLER BD	1	EA	A031
992 8191 003	PWA, A/D BOARD	1	EA	A032
992 8193 001	MOD ENCODER BD	4	EA	A026,A027,A028,A029
992 8193 002	MOD ENCODER BD/BINARY	1	EA	A025
992 8196 001	BUFFER AMP BD	1	EA	A004
992 8201 001	PWA, RF SPLITTER, ESD SAFE	1	EA	A006
992 8354 002	PAC CABLE PKG FA	1	EA	
992 8363 001	AIR FLOW MONITOR	4	EA	A024,A047,A048,A049
992 8538 001	PWA, DRIVER MOTHERBD, ESD SAFE	1	EA	A005
992 8539 002	EFFICIENCY COIL OCTAL,ESD SAFE	1	EA	A010A1
992 8539 003	EFFICIENCY COIL OCTAL,ESD SAFE	21	EA	A005A1,A005A2,A010A2,A011A1,A011A2,A012A1,A012A2,A013A1,A013A2,A014A1,A014A2,A015A1,A015A2,A016A1,A016A2,A017A1,A017A2,A018A1,A018A2,A019A1,A019A2
992 8548 001	PWA, MAIN MOTHERBD, ESD SAFE	9	EA	A011,A012,A013,A014,A015,A016,A017,A018,A019
992 8549 001	PWA, BINARY MOTHERBD, ESD SAFE	1	EA	A010
992 8604 001	PRE DRIVER TUNING BD,	1	EA	A054
992 8605 002	DRIVER TUNING ASSY	1	EA	A053
992 8882 001	ANALOG INPUT BD.	1	EA	A022

Table 7-3. PWA, IPA PWR SPLITTER,ESD SAFE - 992 5889 002 (D)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
610 0873 000	HEADER KIT, 20 PIN EJECT	4	EA	J001,J002,J003,J004
839 5695 273	PC BD, IPA PWR SPLITTER	1		
843 5400 267	COMPONENT LOCATOR, IPA POWER	0		

WARNING: Disconnect primary power prior to servicing.

Table 7-4. PWA, MULTIMETER/PROBE,ESD SAFE - 992 6752 005 (B)

Harris PN	Description	QTY	UM	Reference Designators
384 0431 000	RECT. 1N4001 ESD	2	EA	CR004,CR005
384 0612 000	DIODE 1N3070 ESD	1	EA	CR001
516 0530 000	CAP .01UF 10% 100V X7R	1	EA	C003
516 0555 000	CAP .047UF 10% 100V X7R	1	EA	C001
548 2400 401	RES 10K OHM 1/2W 1%	1	EA	R004
548 2400 446	RES 29.4K OHM 1/2W 1%	1	EA	R005
548 2400 543	RES 274K OHM 1/2W 1%	1	EA	R002
548 2400 547	RES 301K OHM 1/2W 1%	1	EA	R003
548 2400 550	RES 324K OHM 1/2W 1%	1	EA	R001
600 0606 000	SW, ROTARY 2P 6 POS	2	EA	S001,S002
604 0605 000	SW, TGL DPDT ALT ACTION	1	EA	S003
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	1	EA	J005
610 0980 000	*HDR 20C RT ANG 2ROW TOP LATCH	1	EA	J004
610 1210 000	JUMPER, FLEX 10C X 2" LG	1	EA	FS001
632 1133 000	AMMETER, 0-3ADC, 4.5",[W]	1		M001
700 1305 000	PROBE W/COILED LEAD, 4 FT	1		E001
839 6208 302	SCH, MULTIMETER	0		
843 4038 202	PWB, MULTIMETER	1		
999 2446 001	HARDWARE LIST	1	EA	

Table 7-5. *PWA, DX SWITCH, - 992 6784 002 (J)

Harris PN	Description	QTY	UM	Reference Designators
358 1928 000	JUMPER 1/4 LG 1/8H	1	EA	JP001
358 3545 003	STANDOFF, PEM 3/8" H SNAP-TOP	4	EA	
380 0189 000	XSTR, NPN 2N3904 ESD	4	EA	Q002,Q003,Q004,Q005
380 0190 000	XSTR, PNP 2N3906 ESD	1	EA	Q001
382 0463 000	IC, 4051/14051 ESD	2	EA	U003,U010
382 0774 000	IC 74HC14 ESD	1	EA	U007
382 0781 000	IC, 74HC74 ESD	1	EA	U011
382 0791 000	IC, 74HC138 ESD	1	EA	U008
382 0800 000	IC, 74HC161 ESD	1	EA	U006
382 0882 000	IC, 78L05A ESD	1	EA	U012
382 1043 000	IC UDN2595 ESD	1	EA	U001
382 1210 000	IC CD4538B ESD	1	EA	U013
382 1387 000	IC MAX637 ESD	1	EA	U014
382 1542 000	IC, OP490 ESD	4	EA	U002,U004,U005,U009
384 0725 000	RECT 1N5818 ESD	1	EA	CR002
384 0827 000	LED LIGHT BAR, GREEN ESD	5	EA	DS001,DS002,DS003,DS004,DS005
384 0849 000	LED LIGHT BAR, GREEN ESD	1	EA	DS008
384 0854 000	DIODE ARRAY, 8 ISOLATED ESD	1	EA	CR001
384 0858 000	LED LIGHT BAR, YELLOW ESD	1	EA	DS009
384 0892 000	LED 4 SEG LIGHTBAR, GRN ESD	2	EA	DS006,DS007
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1	EA	#U014
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6	EA	#U002,#U004,#U005,#U007,#U009,#U011
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8	EA	#CR001,#DS006,#DS007,#U003,#U006,#U008,#U010,#U013
404 0766 000	SOCKET, DIP, 18 PIN (DL)	1	EA	#U001
404 0829 000	SOCKET, SIP20, STRAIGHT	3	EA	#DS001,#DS002,#DS003,#DS004,#DS005,#DS008,#DS009
492 0839 000	IND 330 UH 10% 500MA	1	EA	L001
516 0453 000	CAP .1UF 100V 20% X7R	30	EA	C002,C004,C007,C010,C011,C012,C013,C014,C015,C016,C017,C018,C019,C020,C021,C023,C024,C027,C028,C029,C030,C034,C035,C036,C037,C038,C039,C040,C041,C042

WARNING: Disconnect primary power prior to servicing.

516 0530 000	CAP .01UF 10% 100V X7R	1	EA	C022
516 0792 000	CAP NETWORK .1UF 10%	2	EA	C031,C032
516 0907 000	CAP 0.330UF 10% 50V	1	EA	C025
522 0531 000	CAP 1UF 50V 20%	1	EA	C003
522 0548 000	CAP 10UF 50V 20%	6	EA	C001,C005,C006,C009,C026,C033
522 0569 000	CAP 100UF 50V 20%	1	EA	C008
540 1383 000	RES NETWORK 100K OHM 2%	2	EA	R006,R007
540 1387 000	RES NETWORK 10K OHM 2%	4	EA	R001,R005,R012,R023
540 1408 000	RES NETWORK 2000 OHM 2%	1	EA	R003
540 1440 000	RES NETWORK 2000 OHM 2%	1	EA	R002
540 1461 000	RES NETWORK 100 OHM 2%	9	EA	R004,R026,R027,R028,R029,R030,R032,R033,R034
540 1462 000	RES NETWORK 1000 OHM 2%	1	EA	R024
548 2400 401	RES 10K OHM 1/2W 1%	2	EA	R010,R016
548 2400 436	RES 23.2K OHM 1/2W 1%	1	EA	R015
548 2400 456	RES 37.4K OHM 1/2W 1%	1	EA	R011
548 2400 477	RES 61.9K OHM 1/2W 1%	1	EA	R025
548 2400 530	RES 200K OHM 1/2W 1%	2	EA	R009,R017
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	2	EA	R013,R014
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	1	EA	R008
604 1111 000	SW PB GRAY MOM W/O LED	2	EA	S007,S008
604 1119 000	SW PB RED MOM W/O LED	1	EA	S006
604 1121 000	SW PB BLUE MOM W/O LED	2	EA	S004,S005
604 1152 000	SW PB GRN MOM W/O LED	3	EA	S001,S002,S003
610 0933 000	JUMPER, PWB TEST POINT	8	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008
610 0991 000	HDR, STR, 6 PIN, 0.025 SQ	1	EA	J002
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J001
610 1210 000	JUMPER, FLEX 10C X 2" LG	3	EA	FS001,FS002,FS003
839 6208 301	SCH, SWITCH/METER	0		
843 4038 201	PWB, SWITCH/METER	1		

Table 7-6. PWA, FUSE, ESD SAFE - 992 8007 003 (F)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0257 000	NUT, CAPTIVE 6-32	2	EA	2#F009
324 0321 000	NUT, CAPTIVE 10-32	14	EA	2#F001 2#F002 2#F003 2#F005 2#F006 2#F007 2#F008
384 0341 000	RECTIFIER 1N5404 ESD	8	EA	CR001,CR002,CR003,CR005,CR006,CR007,CR008,CR009
398 0436 000	FUSE 1 TIME 20A 250VAC	1	EA	F009
398 0458 000	FUSE, 35A 250V CRTG	7	EA	F001,F002,F003,F005,F006,F007,F008
402 0004 000	CLIP, FUSE .812 60A 250V	14	EA	2#F001 2#F002 2#F003 2#F005 2#F006 2#F007 2#F008
402 0069 000	CLIP, FUSE BRONZE	2	EA	2#F009
540 1600 419	RES 56K OHM 3W 5%	2	EA	R025,R026
542 0095 000	RES 10K OHM 5% 12W	1	EA	R010
542 0121 000	RES 150 OHM 5% 20W	8	EA	R001,R002,R003,R005,R006,R007,R008,R009
839 7930 030	SCHEMATIC, FUSE BOARD	0		
843 5100 029	PWB, FUSE	1		
999 2576 003	HARDWARE LIST	1	EA	

Table 7-7. PWA, FUSE, ESD SAFE - 992 8007 004 (G)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0321 000	NUT, CAPTIVE 10-32	16	EA	2#F001 2#F002 2#F003 2#F004 2#F005 2#F006 2#F007 2#F008
384 0341 000	RECTIFIER 1N5404 ESD	8	EA	CR001,CR002,CR003,CR004,CR005,CR006,CR007,CR008
398 0458 000	FUSE, 35A 250V CRTG	8	EA	F001,F002,F003,F004,F005,F006,F007,F008
402 0004 000	CLIP, FUSE .812 60A 250V	16	EA	#F001,#F002,#F003,#F004,#F005,#F006,#F007,#F008

WARNING: Disconnect primary power prior to servicing.

508 0549 000	CAP .33UF 5% 400VDC	1	EA	C003
542 0095 000	RES 10K OHM 5% 12W	1	EA	R010
542 0121 000	RES 150 OHM 5% 20W	8	EA	R001,R002,R003,R004,R005,R006,R007,R008
548 2400 385	RES 7.5K OHM 1/2W 1%	1	EA	R021
548 2400 401	RES 10K OHM 1/2W 1%	1	EA	R024
548 2400 407	RES 11.5K OHM 1/2W 1%	1	EA	R018
548 2400 466	RES 47.5K OHM 1/2W 1%	2	EA	R022,R023
548 2400 518	RES 150K OHM 1/2W 1%	4	EA	R016,R017,R019,R020
548 2400 547	RES 301K OHM 1/2W 1%	1	EA	R027
610 0999 000	HDR, 10 PIN, PC BD	1	EA	J002
620 0515 000	RECP, SCREW ON SMC	1	EA	J001
839 7930 030	SCHEMATIC, FUSE BOARD	0		
843 5100 029	PWB, FUSE	1		
999 2576 004	HARDWARE LIST	1	EA	

Table 7-8. RF AMPLIFIER MODULE - 992 8179 001 (L)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0281 000	NUT, CAPTIVE 4-40	2	EA	
328 0071 000	WASHER, STEEL COMPRESSION	4	EA	#Q001,#Q002,#Q007,#Q008
380 0126 000	XSTR, PNP 2N4403 ESD	2	EA	Q017,Q018
380 0653 000	XSTR, NPN MPS6602 ESD	2	EA	Q009,Q010
380 0708 000	XSTR MPS6652 40V 1A ESD	4	EA	Q011,Q012,Q013,Q014
380 0712 000	XSTR, NPN 2N6718 ESD	2	EA	Q015,Q016
380 0722 000	XSTR IRFP360 ESD	8	EA	Q001,Q002,Q003,Q004,Q005,Q006,Q007,Q008
384 0253 000	RECTIFIER 1N4007 ESD	2	EA	CR011,CR012
384 0612 000	DIODE 1N3070 ESD	4	EA	CR017,CR018,CR019,CR020
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	1	EA	DS003
384 0802 000	TRANSZORB, BIPOLAR 18V 5% ESD	4	EA	CR001,CR002,CR003,CR004
384 0803 000	RECT MUR-120 200V ESD	8	EA	CR007,CR008,CR009,CR010,CR015,CR016,CR021,CR022
384 0810 000	LED, RED, T1, RT ANG ESD	2	EA	DS001,DS002
384 0817 000	RECT, SCHOTTKY, CRSH2-3 ESD	2	EA	CR005,CR006
386 0100 000	ZENER, 1N4747A 20V ESD	1	EA	CR025
398 0465 000	FUSE, FAST CART 2A 250V	2	EA	F003,F004
398 0466 000	FUSE 1TIME MIDGET 6A 250V	2	EA	F001,F002
402 0194 000	CLIP FUSE BRONZE	4	EA	2#F001 2#F002
402 0198 000	CLIP, FUSE 5MM DIA FUSE	4	EA	2#F003 2#F004
410 0413 000	THERMAL INTERFACE, TO-247	8	EA	#Q001,#Q002,#Q003,#Q004,#Q005,#Q006,#Q007,#Q008
414 0343 000	FERRITE TOROID, 0.155 OD	4	EA	#Q005,#Q006,#Q007,#Q008
494 0249 000	CHOKE RF 10UH	6	EA	L001,L002,L003,L004,L005,L006
494 0404 000	CHOKE RF 33.0UH	1	EA	L011
500 0754 000	CAP, MICA, 220PF 500V 5%	0	EA	C009,C010
500 0759 000	CAP, MICA, 100PF 500V 5%	0	EA	C009,C010
500 0784 000	CAP, MICA, 300PF 500V 5%	0	EA	C009,C010
500 0787 000	CAP, MICA, 200PF 500V 5%	0	EA	C009,C010
500 0834 000	CAP, MICA, 430PF 500V 5%	0	EA	C009,C010
500 0839 000	CAP, MICA, 620PF 300V 5%	0	EA	C009,C010
500 0842 000	CAP, MICA, 820PF 300V 5%	0	EA	C009,C010
500 0844 000	CAP, MICA, 1000PF 100V 5%	0	EA	C009,C010
500 0903 000	CAP, MICA, 2700PF 500V 5%	2	EA	C007,C008
500 1164 000	CAP, MICA, 1800PF 500V 5%	3	EA	C005,C006,C016
506 0235 000	CAP .0033UF 100V 5%	2	EA	C021,C022
506 0239 000	CAP, 0.022UF 100V 5%	2	EA	C011,C012
506 0240 000	CAP, 0.033UF 100V 5%	2	EA	C013,C014
506 0264 000	CAP 2.2UF 10% 400VDC	2	EA	C001,C002

WARNING: Disconnect primary power prior to servicing.

508 0550 000	CAP .1UF 600V 5%	1	EA	C015
516 0419 000	CAP .05 UF 500V	2	EA	C003,C004
540 1600 017	RES 4.7 OHM 3W 5%	2	EA	R007,R008
540 1600 412	RES 30K OHM 3W 5%	1	EA	R031
540 1600 419	RES 56K OHM 3W 5%	2	EA	R001,R002
542 1600 000	RES 0.1 OHM 5W 5%	2	EA	R027,R028
546 0313 000	RES 50 OHM 5W 5%	4	EA	R009,R010,R013,R014
548 2400 101	RES 10 OHM 1/2W 1%	4	EA	R003,R004,R005,R006
548 2400 201	RES 100 OHM 1/2W 1%	2	EA	R025,R026
548 2400 218	RES 150 OHM 1/2W 1%	6	EA	R021,R022,R023,R024,R029,R030
548 2400 230	RES 200 OHM 1/2W 1%	2	EA	R017,R018
548 2400 342	RES 2.67K OHM 1/2W 1%	2	EA	R015,R016
548 2400 430	RES 20K OHM 1/2W 1%	2	EA	R019,R020
548 2400 566	RES 475K OHM 1/2W 1%	2	EA	R011,R012
610 0933 000	JUMPER, PWB TEST POINT	2	EA	TP001,TP002
839 7930 001	SCHEM, RF AMPLIFIER	0		
843 5155 001	PWB, RF AMPLIFIER	1		
922 0922 156	TRANSFORMER	2	EA	T001,T002
943 5155 064	HEATSINK SET	1	EA	
999 2561 002	HARDWARE LIST	1	EA	

Table 7-9. PWA, PWR DISTRIBUTION,ESD SAFE - 992 8187 001 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
610 1107 000	HDR,12PIN,1ROW,STRT,POL	10	EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010
839 7930 016	SCHEM, POWER DISTRIBUTION	0		
843 5155 016	PWB, POWER DISTRIBUTION	1		
999 2640 001	HARDWARE LIST	1	EA	

Table 7-10. LED BD - 992 8188 001 (J)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
335 0262 000	DF137A INSULATING WASHER	2	EA	U005
354 0309 000	TERM SOLDER	6	EA	TP001,TP002,TP003,TP004,TP005,TP006
358 1928 000	JUMPER 1/4 LG 1/8H	5	EA	JP001,JP007,JP008,JP010,JP012
358 2177 000	SPACER, LED MOUNT .380 LG	29	EA	#DS001,#DS002,#DS003,#DS004,#DS005,#DS006,#DS007,#DS008,#DS009,#DS010,#DS011,#DS012,#DS013,#DS014,#DS015,#DS016,#DS017,#DS018,#DS019,#DS020,#DS021,#DS022,#DS023,#DS024,#DS025,#DS026,#DS027,#DS028,#DS029
380 0319 000	XSTR, MPS-A14 ESD	1	EA	Q001
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U005
382 0817 000	IC, 74HC244 ESD	4	EA	U006,U007,U008,U009
382 1171 000	IC 74HC540 (ESD)	4	EA	U001,U002,U003,U004
384 0610 000	* LED, GREEN T-1 3/4 ESD	1	EA	DS029
384 0611 000	*LED, RED T1-3/4 ESD	1	EA	DS028
384 0651 000	RECTIFIER 1N5401 ESD	2	EA	CR003,CR004
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR002
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR001
384 0806 000	LED, BI-COLOR RED/GREEN ESD	27	EA	DS001,DS002,DS003,DS004,DS005,DS006,DS007,DS008,DS009,DS010,DS011,DS012,DS013,DS014,DS015,DS016,DS017,DS018,DS019,DS020,DS021,DS022,DS023,DS024,DS025,DS026,DS027
404 0513 000	HEAT SINK PA1-1CB	1	EA	#U005
404 0675 000	SOCKET, DIP, 16 PIN (DL)	4	EA	XR001,XR002,XR003,XR004
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8	EA	XU001,XU002,XU003,XU004,XU006,XU007,XU008,XU009

WARNING: Disconnect primary power prior to servicing.

410 0405 000	THERMAL INTERFACE, TO220	1	EA	U005
516 0453 000	CAP .1UF 100V 20% X7R	10	EA	C002,C003,C004,C005,C006,C007,C008,C009,C010,C011
522 0550 000	CAP 100UF 25V 20%	1	EA	C001
540 1434 000	RES NETWORK 330 OHM 2%	1	EA	R009
540 1457 000	RES NETWORK 330 OHM 2%	4	EA	R001,R002,R003,R004
548 2400 401	RES 10K OHM 1/2W 1%	2	EA	R006,R007
548 2400 566	RES 475K OHM 1/2W 1%	2	EA	R005,R008
604 0905 000	SW, PB MOMENTARY	2	EA	S002,S003
604 1089 000	SW, TGL SPDT PC MOUNT	1	EA	S001
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	2	EA	J001,J002
839 7930 006	SCHEM, LED BOARD	0		
843 5155 006	PWB, LED BOARD	1		
999 2624 001	HARDWARE LIST	1	EA	

Table 7-11. CONTROLLER BD - 992 8189 001 (Y)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	31	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031
358 3423 000	JUMPER 0.4" LG 1/8" HEIGHT	4	EA	JP055,JP056,JP057,JP061
380 0125 000	XSTR, NPN 2N4401 ESD	1	EA	Q001
380 0126 000	XSTR, PNP 2N4403 ESD	2	EA	Q002,Q003
380 0678 000	*XSTR, ARRAY QUAD 2222 ESD	4	EA	U040,U041,U042,U043
382 0184 000	IC, 340T-5/7805 +5V REG ESD	2	EA	U051,U052
382 0739 000	IC 555 CMOS ESD	1	EA	U020
382 0800 000	IC, 74HC161 ESD	5	EA	U015,U016,U017,U018,U019
382 0817 000	IC, 74HC244 ESD	5	EA	U030,U031,U032,U033,U034
382 0882 000	IC, 78L05A ESD	1	EA	U053
382 1065 000	IC 74HCT273 ESD	6	EA	U021,U022,U023,U024,U025,U026
382 1084 000	IC, LP339N ESD	2	EA	U036,U037
382 1171 000	IC 74HC540 (ESD)	1	EA	U014
384 0321 000	*DIODE 5082-2800 ESD	5	EA	CR102,CR105,CR107,CR129,CR130
384 0431 000	RECT. 1N4001 ESD	5	EA	CR143,CR144,CR148,CR153,CR155
384 0610 000	* LED, GREEN T-1 3/4 ESD	2	EA	DS005,DS006
384 0612 000	DIODE 1N3070 ESD	46	EA	CR007,CR017,CR018,CR019,CR021,CR025,CR026,CR027,CR028,CR035,CR036,CR038,CR039,CR040,CR041,CR042,CR043,CR046,CR047,CR048,CR049,CR058,CR059,CR060,CR061,CR062,CR063,CR064,CR065,CR066,CR067,CR068,CR069,CR070,CR071,CR072,CR073,CR125,CR127,CR131,CR132,CR133,CR142,CR157,CR158,CR159
384 0651 000	RECTIFIER 1N5401 ESD	2	EA	CR140,CR141
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	28	EA	CR001,CR002,CR003,CR004,CR006,CR014,CR015,CR016,CR029,CR030,CR031,CR032,CR033,CR034,CR037,CR092,CR093,CR094,CR095,CR103,CR104,CR106,CR108,CR109,CR110,CR126,CR139,CR145
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR160
384 0806 000	LED, BI-COLOR RED/GREEN ESD	4	EA	DS001,DS002,DS003,DS004
386 0078 000	ZENER, 1N4734A 5.6V ESD	2	EA	CR122,CR123
386 0135 000	ZENER, 1N4733A 5.1V ESD	47	EA	CR008,CR009,CR010,CR011,CR012,CR013,CR020,CR022,CR023,CR052,CR053,CR054,CR055,CR056,CR057,CR074,CR075,CR076,CR077,CR078,CR079,CR080,CR081,CR082,CR083,CR084,CR085,CR086,CR087,CR088,CR089,CR090,CR091,CR096,CR097,CR098,CR099,CR100,CR101,CR111,CR114,CR116,CR117,CR118,CR119,CR124,CR128
386 0428 000	DIODE LM385-1.2 1.235V 1% ESD	1	EA	CR138
398 0465 000	FUSE, FAST CART 2A 250V	6	EA	F001,F002,F003,F004,F005,F006
402 0198 000	CLIP, FUSE 5MM DIA FUSE	12	EA	2#F001 2#F002 2#F003 2#F004 2#F005 2#F006

WARNING: Disconnect primary power prior to servicing.

404 0513 000	HEAT SINK PA1-1CB	2	EA	#U051,#U052
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1	EA	XU020
404 0674 000	SOCKET, DIP, 14 PIN (DL)	6	EA	XU036,XU037,XU040,XU041,XU042,XU043
404 0675 000	SOCKET, DIP, 16 PIN (DL)	5	EA	XU015,XU016,XU017,XU018,XU019
404 0767 000	SOCKET, DIP, 20 PIN (DL)	12	EA	XU014,XU021,XU022,XU023,XU024,XU025,XU026,XU030,XU031,XU032,XU033,XU034
404 0797 000	SOCKET, DIP, 24 PIN (DL)	13	EA	XU001,XU002,XU003,XU004,XU005,XU006,XU007,XU008,XU009,XU010,XU011,XU012,XU013
506 0234 000	CAP .0022UF 100V 5%	1	EA	C070
506 0245 000	CAP, 0.33UF 63V 5%	1	EA	C045
516 0453 000	CAP .1UF 100V 20% X7R	47	EA	C001,C002,C003,C004,C005,C006,C007,C008,C009,C010,C011,C012,C013,C014,C015,C016,C017,C019,C020,C021,C022,C023,C024,C025,C026,C027,C030,C031,C032,C033,C034,C036,C037,C038,C039,C040,C042,C043,C044,C048,C050,C051,C059,C060,C063,C065,C071
516 0530 000	CAP .01UF 10% 100V X7R	1	EA	C064
516 0736 000	CAP .001UF 10% 100V X7R	8	EA	C052,C053,C054,C055,C066,C067,C068,C073
516 0790 000	CAP NTWK 1000PF 10% 50V	9	EA	C101,C103,C104,C105,C106,C107,C108,C109,C110
516 0792 000	CAP NETWORK .1UF 10%	1	EA	C102
522 0550 000	CAP 100UF 25V 20%	4	EA	C049,C061,C062,C072
526 0108 000	CAP 4.7UF 35V 20%	1	EA	C069
526 0374 000	CAP 1.0F 5.5V	2	EA	C046,C047
540 1353 000	RES NETWORK 4700 OHM 2%	1	EA	R145
540 1356 000	RES NETWORK 10K OHM 2%	11	EA	R102,R107,R108,R109,R110,R122,R127,R128,R129,R130,R168
540 1359 000	RES NETWORK 3300 OHM	2	EA	R170,R171
540 1365 000	RES NETWORK 36 OHM 2%	2	EA	R105,R125
540 1366 000	RES NETWORK 100 OHM 2%	8	EA	R101,R103,R104,R106,R121,R123,R124,R126
540 1382 000	RES NETWORK 47K OHM 2%	1	EA	R165
540 1386 000	RES NETWORK 10K OHM 2%	1	EA	R143
540 1457 000	RES NETWORK 330 OHM 2%	1	EA	R169
540 1493 000	RES NETWORK 100K OHM	6	EA	R142,R146,R147,R148,R149,R150
548 2400 151	RES 33.2 OHM 1/2W 1%	2	EA	R035,R049
548 2400 201	RES 100 OHM 1/2W 1%	13	EA	R011,R012,R027,R028,R031,R037,R074,R082,R083,R084,R085,R096,R097
548 2400 251	RES 332 OHM 1/2W 1%	3	EA	R014,R054,R062
548 2400 301	RES 1K OHM 1/2W 1%	1	EA	R047
548 2400 366	RES 4.75K OHM 1/2W 1%	3	EA	R034,R052,R056
548 2400 380	RES 6.65K OHM 1/2W 1%	1	EA	R046
548 2400 401	RES 10K OHM 1/2W 1%	33	EA	R001,R002,R003,R004,R005,R006,R007,R008,R013,R022,R023,R025,R026,R040,R041,R045,R055,R057,R060,R063,R064,R075,R076,R077,R078,R081,R086,R087,R088,R089,R090,R091,R094
548 2400 405	RES 11K OHM 1/2W 1%	1	EA	R015
548 2400 412	RES 13K OHM 1/2W 1%	1	EA	R042
548 2400 413	RES 13.3K OHM 1/2W 1%	1	EA	R048
548 2400 430	RES 20K OHM 1/2W 1%	1	EA	R095
548 2400 455	RES 36.5K OHM 1/2W 1%	1	EA	R043
548 2400 458	RES 39.2K OHM 1/2W 1%	1	EA	R061
548 2400 466	RES 47.5K OHM 1/2W 1%	6	EA	R029,R036,R039,R050,R051,R092
548 2400 474	RES 57.6K OHM 1/2W 1%	1	EA	R016
548 2400 485	RES 75K OHM 1/2W 1%	1	EA	R093
548 2400 487	RES 78.7K OHM 1/2W 1%	1	EA	R033
548 2400 501	RES 100K OHM 1/2W 1%	11	EA	R009,R010,R017,R019,R021,R024,R059,R067,R073,R079,R080
548 2400 542	RES 267K OHM 1/2W 1%	1	EA	R044
548 2400 547	RES 301K OHM 1/2W 1%	2	EA	R053,R069
548 2400 558	RES 392K OHM 1/2W 1%	1	EA	R066
548 2400 566	RES 475K OHM 1/2W 1%	1	EA	R071

WARNING: Disconnect primary power prior to servicing.

548 2400 581	RES 681K OHM 1/2W 1%	1	EA	R072
548 2400 601	RES 1MEG OHM 1/2W 1%	2	EA	R065,R070
604 0905 000	SW, PB MOMENTARY	5	EA	S002,S003,S004,S005,S006
604 1089 000	SW, TGL SPDT PC MOUNT	1	EA	S001
610 0679 000	PLUG, SHORTING, .25" CTRS	1	EA	P053
610 0900 000	HEADER 3 CKT STRAIGHT	1	EA	#P050
610 0918 000	HEADER SINGLE ROW 16 PIN	1	EA	J016
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	2	EA	J004,J014
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	9	EA	J001,J002,J003,J005,J006,J007,J008,J012,J013
610 1070 000	HDR 6 PIN STRAIGHT	1	EA	#P052
610 1107 000	HDR,12PIN,1ROW,STRT,POL	3	EA	J009,J010,J011
612 0904 000	JACK, PC MT GOLD PLATED	3	EA	#P053
612 1184 000	SHUNT JUMPER 0.1" CENTERS	2	EA	P050,P052
839 7930 021	SCHEM, CONTROLLER	0		
843 5155 021	PWB, CONTROLLER	1		
917 2210 001	FBTIM 8.0 FIRMWARE	1	EA	U002
917 2210 002	FGATE1 8.0 FIRMWARE	1	EA	U009
917 2210 003	FGATE2 8.0 FIRMWARE	1	EA	U010
917 2210 004	FLDBK 8.0 FIRMWARE	1	EA	U001
917 2210 005	FLT1 8.0 FIRMWARE	1	EA	U003
917 2210 006	FTIM 8.0 FIRMWARE	1	EA	U004
917 2210 007	LR 8.0 FIRMWARE	1	EA	U006
917 2210 008	OPR 8.0 FIRMWARE	1	EA	U005
917 2210 009	PTIM 8.0 FIRMWARE	1	EA	U008
917 2210 010	PWR 8.0 FIRMWARE	1	EA	U007
917 2210 011	LATCH 8.0 FIRMWARE	3	EA	U011,U012,U013
999 2626 001	HARDWARE LIST	1	EA	

Table 7-12. PWA, A/D BOARD - 992 8191 003 (M)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	21	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP009,TP010,TP011,TP012,TP013,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024
358 1928 000	JUMPER 1/4 LG 1/8H	4	EA	JP008,JP014,JP018,JP019
380 0125 000	XSTR, NPN 2N4401 ESD	5	EA	Q001,Q002,Q003,Q005,Q006
380 0126 000	XSTR, PNP 2N4403 ESD	1	EA	Q004
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U023
382 0359 000	IC, 7815 ESD	1	EA	U021
382 0360 000	IC, 7915 ESD	1	EA	U022
382 0472 000	IC, LM318 ESD	3	EA	U016,U018,U019
382 0646 000	* IC DAC0808 ESD	1	EA	U015
382 0749 000	IC NE5532A ESD	2	EA	U012,U014
382 0781 000	IC, 74HC74 ESD	1	EA	U004
382 0817 000	IC, 74HC244 ESD	2	EA	U008,U009
382 0865 000	IC, 74HC4538 ESD	1	EA	U030
382 0882 000	IC, 78L05A ESD	1	EA	U026
382 0965 000	IC, D/A CONVERTER ESD	1	EA	U011
382 1065 000	IC 74HCT273 ESD	2	EA	U006,U007
382 1080 000	IC 74HCT04 HEX INVERTER ESD	1	EA	U010
382 1084 000	IC, LP339N ESD	1	EA	U025
382 1627 000	IC OP27 OPAMP ESD	3	EA	U001,U031,U032
382 1628 000	IC LM4040AIZ-5.0 ESD	1	EA	CR001
383 0287 000	IC ADC12662 1.5MHZ ESD	1	EA	U003
384 0431 000	RECT. 1N4001 ESD	5	EA	CR005,CR006,CR007,CR021,CR022

WARNING: Disconnect primary power prior to servicing.

384 0612 000	DIODE 1N3070 ESD	6	EA	CR002,CR003,CR004,CR008,CR009,CR013
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	3	EA	DS001,DS002,DS003
384 0662 000	LED RED ESD	2	EA	DS005,DS006
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR016
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	2	EA	CR017,CR019
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	2/F001 2/F002 2/F003
404 0513 000	HEAT SINK PA1-1CB	3	EA	XU021,XU022,XU023
404 0673 000	SOCKET, DIP, 8 PIN (DL)	8	EA	XU001,XU012,XU014,XU016,XU018,XU019,XU031,XU032
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3	EA	XU004,XU010,XU025
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2	EA	XU015,XU030
404 0682 000	SOCKET, DIP, 24 PIN (DL)	1	EA	XU011
404 0767 000	SOCKET, DIP, 20 PIN (DL)	4	EA	XU006,XU007,XU008,XU009
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1	EA	XU005
404 0830 000	SOCKET, PLCC-44, THROUGH HOLE	1	EA	XU003
484 0334 000	LINE,DELAY 60+/-2.0 NSEC	1	EA	DL001
494 0218 000	CHOKE, WIDE BAND 2.5 TURN	1	EA	RFC1
494 0411 000	CHOKE RF 220.0UH	1	EA	L003
494 0418 000	CHOKE RF 820.0UH	2	EA	L001,L002
500 0754 000	CAP, MICA, 220PF 500V 5%	2	EA	C002,C004
500 0756 000	CAP, MICA, 330PF 500V 5%	2	EA	C024,C049
500 0759 000	CAP, MICA, 100PF 500V 5%	1	EA	C081
500 0805 000	CAP, MICA, 12PF 500V 5%	1	EA	C012
500 0814 000	CAP, MICA, 36PF 500V 5%	1	EA	C041
500 0834 000	CAP, MICA, 430PF 500V 5%	1	EA	C034
500 0844 000	CAP, MICA, 1000PF 100V 5%	2	EA	C032,C033
506 0239 000	CAP, 0.022UF 100V 5%	1	EA	C085
516 0453 000	CAP .1UF 100V 20% X7R	39	EA	C005,C007,C009,C011,C013,C014,C015,C016,C017,C018,C019,C020,C021,C023,C025,C027,C028,C030,C031,C037,C038,C039,C040,C044,C045,C051,C052,C055,C056,C062,C066,C070,C071,C072,C075,C076,C077,C078,C084
516 0530 000	CAP .01UF 10% 100V X7R	15	EA	C006,C008,C022,C026,C029,C043,C046,C047,C050,C053,C054,C057,C073,C082,C083
516 0725 000	CAP 1.0UF 50V 20%	11	EA	C001,C003,C036,C042,C060,C061,C064,C065,C068,C069,C086
516 0765 000	CAP 10PF 5% 100V C0G	4	EA	C035,C048,C058,C080
522 0548 000	CAP 10UF 50V 20%	5	EA	C010,C074,C079,C087,C088
522 0555 000	CAP 100UF 50V 20%	4	EA	C059,C063,C067,C089
540 1600 215	RES 390 OHM 3W 5%	1	EA	R077
548 2400 169	RES 51.1 OHM 1/2W 1%	3	EA	R010,R011,R082
548 2400 201	RES 100 OHM 1/2W 1%	3	EA	R029,R073,R074
548 2400 251	RES 332 OHM 1/2W 1%	3	EA	R047,R071,R072
548 2400 268	RES 499 OHM 1/2W 1%	2	EA	R038,R048
548 2400 269	RES 511 OHM 1/2W 1%	2	EA	R033,R036
548 2400 277	RES 619 OHM 1/2W 1%	2	EA	R019,R022
548 2400 301	RES 1K OHM 1/2W 1%	6	EA	R013,R044,R046,R055,R056,R069
548 2400 309	RES 1.21K OHM 1/2W 1%	2	EA	R045,R084
548 2400 326	RES 1.82K OHM 1/2W 1%	2	EA	R075,R076
548 2400 337	RES 2.37K OHM 1/2W 1%	2	EA	R017,R037
548 2400 342	RES 2.67K OHM 1/2W 1%	1	EA	R059
548 2400 351	RES 3.32K OHM 1/2W 1%	4	EA	R012,R039,R041,R050
548 2400 358	RES 3.92K OHM 1/2W 1%	1	EA	R018
548 2400 373	RES 5.62K OHM 1/2W 1%	3	EA	R023,R024,R025
548 2400 385	RES 7.5K OHM 1/2W 1%	2	EA	R034,R035
548 2400 389	RES 8.25K OHM 1/2W 1%	1	EA	R051
548 2400 393	RES 9.09K OHM 1/2W 1%	1	EA	R066

WARNING: Disconnect primary power prior to servicing.

548 2400 401	RES 10K OHM 1/2W 1%	27	EA	R001,R004,R006,R007,R014,R015,R016,R020,R021,R030,R031,R040,R053,R057,R058,R063,R064,R067,R068,R070,R083,R086,R088,R089,R090,R092,R093
548 2400 402	RES 10.2K OHM 1/2W 1%	1	EA	R002
548 2400 428	RES 19.1K OHM 1/2W 1%	1	EA	R060
548 2400 431	RES 20.5K OHM 1/2W 1%	1	EA	R003
548 2400 434	RES 22.1K OHM 1/2W 1%	4	EA	R052,R054,R062,R065
548 2400 442	RES 26.7K OHM 1/2W 1%	1	EA	R049
548 2400 451	RES 33.2K OHM 1/2W 1%	1	EA	R042
548 2400 501	RES 100K OHM 1/2W 1%	6	EA	R026,R032,R043,R078,R080,R087
548 2400 577	RES 619K OHM 1/2W 1%	1	EA	R005
548 2400 581	RES 681K OHM 1/2W 1%	2	EA	R079,R081
604 1064 000	SWITCH, ROCKER DIP 2-SPST	1	EA	S001
610 0811 000	PROGRAM HEADER 16 PIN DIP	2	EA	R027,R028
610 0900 000	HEADER 3 CKT STRAIGHT	1	EA	JP017
610 0979 000	*HDR 10C VERT 2ROW TOP LATCH	1	EA	J004
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J001
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J002
610 1121 000	HDR 4C 2ROW STRAIGHT	1	EA	JP011
612 1184 000	SHUNT JUMPER 0.1" CENTERS	3	EA	1/#JP017,2/#JP011
620 0515 000	RECP, SCREW ON SMC	1	EA	J003
843 5458 471	SCH, A/D BOARD	0		
843 5458 473	PWB, A/D	1		
917 2210 014	FIRMWARE, A/D FAULT DETECT	1	EA	U005
999 2630 002	HARDWARE LIST, *PWA, A/D BD	1	EA	

Table 7-13. MOD ENCODER BD - 992 8193 001 (AC)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0281 000	NUT, CAPTIVE 4-40	2	EA	#U042
354 0309 000	TERM SOLDER	35	EA	#CR055,#CR056,TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033
356 0084 000	CABLE TY RAP	1.0	EA	TO BE MODIFIED BY 'OP' INSTRUCTION SHEETS AND USED AS A WASHER
358 2684 000	PC BD STANDOFF 4-40X.125	6	EA	
380 0125 000	XSTR, NPN 2N4401 ESD	4	EA	Q002,Q003,Q004,Q005
380 0126 000	XSTR, PNP 2N4403 ESD	1	EA	Q001
380 0678 000	*XSTR, ARRAY QUAD 2222 ESD	1	EA	U035
382 0184 000	IC, 340T-5/7805 +5V REG ESD	2	EA	U043,U046
382 0443 000	IC, CD4053BE ESD	1	EA	U044
382 0594 000	*IC TL074ACN ESD	1	EA	U038
382 0746 000	IC, 79L05AC ESD	1	EA	U039
382 0749 000	IC NE5532A ESD	1	EA	U047
382 0774 000	IC 74HC14 ESD	4	EA	U003,U015,U048,U049
382 1031 000	IC, LM338K ESD	1	EA	U042
382 1065 000	IC 74HCT273 ESD	5	EA	U001,U016,U021,U022,U033
382 1084 000	IC, LP339N ESD	3	EA	U034,U036,U037
382 1150 000	IC 74HC682 (ESD)	1	EA	U004
382 1199 000	IC, LM35 ESD	1	EA	U040
382 1202 000	IC PA 02 ESD	1	EA	U045
382 1204 000	IC TC4423 ESD	16	EA	U007,U008,U009,U010,U011,U012,U013,U014,U023,U024,U027,U028,U029,U030,U031,U032
384 0431 000	RECT. 1N4001 ESD	4	EA	CR005,CR042,CR043,CR058

WARNING: Disconnect primary power prior to servicing.

384 0612 000	DIODE 1N3070 ESD	24	EA	CR002,CR003,CR004,CR006,CR007,CR008,CR017,CR021,CR024,CR025,CR026,CR027,CR028,CR029,CR030,CR031,CR035,CR038,CR044,CR045,CR046,CR047,CR048,CR051
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	5	EA	DS008,DS011,DS012,DS013,DS014
384 0662 000	LED RED ESD	8	EA	DS002,DS003,DS004,DS005,DS006,DS007,DS009,DS010
384 0664 000	LED YELLOW ESD	1	EA	DS001
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	7	EA	CR033,CR034,CR036,CR037,CR041,CR054,CR057
384 0838 000	TRANSZORB 1N6380 36V 5W ESD	2	EA	CR049,CR050
386 0016 000	ZENER 1N2974A 10V 10W 10% ESD	1	EA	CR055
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	4	EA	CR018,CR020,CR022,CR039
386 0100 000	ZENER, 1N4747A 20V ESD	4	EA	CR019,CR023,CR032,CR040
386 0123 000	ZENER, 1N4732A 4.7V ESD	1	EA	CR001
386 0425 000	ZENER 1N2974(R) 10V 10W ESD	1	EA	CR056
398 0020 000	FUSE, FAST CART 3A 250V	1	EA	F004
398 0021 000	FUSE, FAST CART 4A 250V	1	EA	F002
398 0022 000	FUSE, FAST CART 5A 250V	1	EA	F003
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F005,F006
402 0129 000	CLIP, 1/4 DIA FUSE	6	EA	XF002,XF003,XF004
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	XF001,XF005,XF006
404 0509 000	SOCKET, DIP, 28 PIN (DL)	4	EA	XU005,XU006,XU025,XU026
404 0513 000	HEAT SINK PA1-1CB	2	EA	#U043,#U046
404 0673 000	SOCKET, DIP, 8 PIN (DL)	17	EA	XU007,XU008,XU009,XU010,XU011,XU012,XU013,XU014,XU023,XU024,XU027,XU028,XU029,XU030,XU031,XU032,XU047
404 0674 000	SOCKET, DIP, 14 PIN (DL)	11	EA	XU003,XU015,XU019,XU020,XU034,XU035,XU036,XU037,XU038,XU048,XU049
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8	EA	XS007,XS008,XU044 XJP001 XJP002 XJP003 XJP004 XJP005
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8	EA	XU001,XU004,XU016,XU017,XU018,XU021,XU022,XU033
404 0790 000	HEATSINK, 8-PIN DIP	16	EA	#U007,#U008,#U009,#U010,#U011,#U012,#U013,#U014,#U023,#U024,#U027,#U028,#U029,#U030,#U031,#U032
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1	EA	XU002
410 0382 000	INSULATOR #4 SCREW	2	EA	#U042
410 0385 000	INSULATOR TO-3 SILICON	1	EA	#U042
410 0440 000	INSULATOR PAD FOR TO-247,	2.0	EA	#U043,#U046
494 0196 000	CHOKE RF 100UH	2	EA	L001,L002
500 0753 000	CAP, MICA, 56PF 500V 5%	3	EA	C039,C065,C066
500 0837 000	CAP, MICA, 510PF 500V 5%	1	EA	C069
500 0845 000	CAP, MICA, 2000PF 500V 5%	1	EA	C067
506 0235 000	CAP .0033UF 100V 5%	32	EA	C020,C021,C022,C026,C028,C030,C032,C034,C036,C038,C040,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107,C108,C109,C112,C113,C114
516 0453 000	CAP .1UF 100V 20% X7R	77	EA	C013,C014,C015,C016,C023,C024,C041,C042,C043,C044,C045,C046,C047,C048,C049,C051,C054,C057,C059,C061,C062,C063,C068,C070,C073,C076,C077,C080,C081,C082,C083,C086,C087,C090,C091,C111,C115,C116,C117,C118,C119,C120,C121,C122,C123,C124,C125,C126,C127,C128,C129,C130,C131,C132,C133,C134,C135,C136,C137,C138,C139,C140,C141,C147,C148,C149,C151,C152,C153,C154,C156,C157,C158,C159,C160,C163,C165
516 0511 000	CAP 0.47UF 100V 20%	1	EA	C164
516 0530 000	CAP .01UF 10% 100V X7R	15	EA	C001,C002,C003,C004,C009,C010,C011,C012,C056,C142,C143,C144,C145,C146,C162
522 0550 000	CAP 100UF 25V 20%	7	EA	C052,C058,C060,C064,C072,C155,C161
526 0050 000	CAP 1UF 35V 20%	16	EA	C005,C006,C007,C008,C017,C018,C019,C071,C074,C075,C078,C079,C084,C085,C088,C089
526 0108 000	CAP 4.7UF 35V 20%	1	EA	C055
526 0109 000	CAP 22UF 25V 20%	1	EA	C110

WARNING: Disconnect primary power prior to servicing.

540 1380 000	RES NETWORK 10K OHM 2%	8	EA	R020,R038,R049,R053,R097,R118,R135,R205
540 1386 000	RES NETWORK 10K OHM 2%	4	EA	R025,R029,R035,R040
540 1430 000	RES NETWORK, 10K OHM 2%	4	EA	R012,R028,R034,R062
540 1443 000	RES NETWORK 27 OHM 2%	2	EA	R021,R022
540 1493 000	RES NETWORK 100K OHM	2	EA	R051,R052
540 1496 000	RES NETWORK 100 OHM	4	EA	R044,R045,R046,R054
540 1600 115	RES 39 OHM 3W 5%	32	EA	R001,R004,R006,R013,R024,R031,R037,R043,R047,R064,R066,R068,R071,R074,R076,R078,R079,R082,R136,R179,R180,R182,R184,R187,R188,R191,R193,R195,R196,R197,R198,R199
540 1600 201	RES 100 OHM 3W 5%	32	EA	R002,R003,R005,R007,R008,R009,R010,R011,R027,R033,R041,R063,R065,R067,R069,R070,R072,R073,R075,R077,R080,R081,R112,R147,R181,R183,R185,R186,R189,R190,R192,R194
540 1600 208	RES 200 OHM 3W 5%	2	EA	R166,R168
542 0051 000	RES 3 OHM 5% 12W	3	EA	R132,R133,R211
542 1600 000	RES 0.1 OHM 5W 5%	1	EA	R144
544 1662 000	RES 30 OHM 20W 2% TO-220	1	EA	R115
548 2400 030	RES 2 OHM 1/2W 1%	1	EA	R145
548 2400 185	RES 75 OHM 1/2W 1%	3	EA	R105,R110,R114
548 2400 201	RES 100 OHM 1/2W 1%	2	EA	R143,R171
548 2400 219	RES 154 OHM 1/2W 1%	1	EA	R125
548 2400 230	RES 200 OHM 1/2W 1%	1	EA	R226
548 2400 251	RES 332 OHM 1/2W 1%	6	EA	R059,R092,R093,R094,R095,R096
548 2400 258	RES 392 OHM 1/2W 1%	5	EA	R116,R155,R163,R172,R212
548 2400 266	RES 475 OHM 1/2W 1%	2	EA	R085,R138
548 2400 269	RES 511 OHM 1/2W 1%	2	EA	R139,R169
548 2400 281	RES 681 OHM 1/2W 1%	2	EA	R126,R156
548 2400 285	RES 750 OHM 1/2W 1%	1	EA	R124
548 2400 301	RES 1K OHM 1/2W 1%	11	EA	R016,R050,R055,R056,R057,R058,R060,R083,R084,R146,R152
548 2400 321	RES 1.62K OHM 1/2W 1%	1	EA	R221
548 2400 330	RES 2K OHM 1/2W 1%	2	EA	R157,R161
548 2400 334	RES 2.21K OHM 1/2W 1%	4	EA	R014,R158,R200,R202
548 2400 339	RES 2.49K OHM 1/2W 1%	1	EA	R222
548 2400 347	RES 3.01K OHM 1/2W 1%	1	EA	R107
548 2400 351	RES 3.32K OHM 1/2W 1%	3	EA	R099,R102,R103
548 2400 366	RES 4.75K OHM 1/2W 1%	1	EA	R203
548 2400 385	RES 7.5K OHM 1/2W 1%	1	EA	R130
548 2400 389	RES 8.25K OHM 1/2W 1%	2	EA	R201,R207
548 2400 401	RES 10K OHM 1/2W 1%	37	EA	R015,R017,R018,R019,R023,R061,R088,R091,R098,R117,R120,R122,R123,R127,R128,R137,R149,R153,R154,R159,R160,R165,R167,R175,R176,R177,R178,R204,R206,R208,R216,R218,R219,R220,R223,R224,R225
548 2400 413	RES 13.3K OHM 1/2W 1%	1	EA	R129
548 2400 430	RES 20K OHM 1/2W 1%	1	EA	R100
548 2400 434	RES 22.1K OHM 1/2W 1%	2	EA	R140,R142
548 2400 438	RES 24.3K OHM 1/2W 1%	1	EA	R131
548 2400 440	RES 25.5K OHM 1/2W 1%	1	EA	R104
548 2400 451	RES 33.2K OHM 1/2W 1%	4	EA	R086,R089,R101,R119
548 2400 458	RES 39.2K OHM 1/2W 1%	1	EA	R164
548 2400 469	RES 51.1K OHM 1/2W 1%	2	EA	R148,R151
548 2400 501	RES 100K OHM 1/2W 1%	8	EA	R109,R113,R141,R209,R210,R214,R215,R217
548 2400 512	RES 130K OHM 1/2W 1%	4	EA	R087,R090,R106,R121
548 2400 589	RES 825K OHM 1/2W 1%	2	EA	R108,R111
548 2400 601	RES 1MEG OHM 1/2W 1%	4	EA	R134,R170,R173,R174
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1	EA	R150
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	1	EA	R213
600 0579 000	SW, ROTARY 4PDT	2	EA	S007,S008

WARNING: Disconnect primary power prior to servicing.

604 0905 000	SW, PB MOMENTARY	1	EA	S006
610 0870 000	PLUG, NON-INS SHORTING	34	EA	#P001A,#P002,#P003,#P004,#P010
610 0900 000	HEADER 3 CKT STRAIGHT	2	EA	XP005,XP006
610 0980 000	*HDR 20C RT ANG 2ROW TOP LATCH	4	EA	J001,J002,J003,J004
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	1	EA	J009
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J008
610 1054 000	HEADER STRAIGHT MNT 8 PIN	1	EA	J006
610 1098 000	HDR, 4 PIN IN-LINE	2	EA	J012,J013
610 1106 000	HDR, 8PIN, 1ROW, STRT,POL	1	EA	J007
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J005
612 0904 000	JACK, PC MT GOLD PLATED	1	EA	P011
612 1176 000	DIP STRIP, FEMALE 10 POS	4	EA	P001A,P002,P003,P004
612 1184 000	SHUNT JUMPER 0.1" CENTERS	2	EA	P005,P006
612 1369 000	JACK, PCB MT, .051 PIN	10	EA	XU042,XU045
839 7930 011	SCHEM, MOD ENCODER	0		
839 7930 105	MOD ENCODER HS	1		
843 5155 011	PWB, MOD ENCODER	1		
917 2150 054	FIRMWARE, MOD ENCODER	4	EA	JP001,JP002,JP004,JP005
917 2150 803	4 PIN PLUG, JUMPER PIN1-2, 3-4	1.0	EA	P012
917 2210 016	ROM 8.0 FIRMWARE	4	EA	U005,U006,U025,U026
917 2542 001	ASSY, AIR SENSOR	1	EA	#R115,U041
999 2660 001	HARDWARE LIST	1	EA	

Table 7-14. MOD ENCODER BD/BINARY - 992 8193 002 (AB)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0281 000	NUT, CAPTIVE 4-40	2	EA	#U042
354 0309 000	TERM SOLDER	35	EA	#CR055,#CR056,TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033
356 0084 000	CABLE TY RAP	1.0	EA	TO BE MODIFIED BY 'OP' INSTRUCTION SHEETS AND USED AS A WASHER
358 2684 000	PC BD STANDOFF 4-40X.125	6	EA	
380 0125 000	XSTR, NPN 2N4401 ESD	4	EA	Q002,Q003,Q004,Q005
380 0126 000	XSTR, PNP 2N4403 ESD	1	EA	Q001
380 0678 000	*XSTR, ARRAY QUAD 2222 ESD	1	EA	U035
382 0184 000	IC, 340T-5/7805 +5V REG ESD	2	EA	U043,U046
382 0443 000	IC, CD4053BE ESD	1	EA	U044
382 0580 000	IC, 74LS32 ESD	2	EA	U019,U020
382 0594 000	*IC TL074ACN ESD	1	EA	U038
382 0746 000	IC, 79L05AC ESD	1	EA	U039
382 0749 000	IC NE5532A ESD	1	EA	U047
382 0774 000	IC 74HC14 ESD	4	EA	U003,U015,U048,U049
382 1031 000	IC, LM338K ESD	1	EA	U042
382 1065 000	IC 74HCT273 ESD	7	EA	U001,U016,U017,U018,U021,U022,U033
382 1084 000	IC, LP339N ESD	3	EA	U034,U036,U037
382 1150 000	IC 74HC682 (ESD)	1	EA	U004
382 1199 000	IC, LM35 ESD	1	EA	U040
382 1202 000	IC PA 02 ESD	1	EA	U045
382 1204 000	IC TC4423 ESD	16	EA	U007,U008,U009,U010,U011,U012,U013,U014,U023,U024,U027,U028,U029,U030,U031,U032
384 0431 000	RECT. 1N4001 ESD	4	EA	CR005,CR042,CR043,CR058
384 0612 000	DIODE 1N3070 ESD	24	EA	

WARNING: Disconnect primary power prior to servicing.

				CR002,CR003,CR004,CR006,CR007,CR008,CR017,CR021,CR024,CR025,CR026,CR027,CR028,CR029,CR030,CR031,CR035,CR038,CR044,CR045,CR046,CR047,CR048,CR051
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	5	EA	DS008,DS011,DS012,DS013,DS014
384 0662 000	LED RED ESD	8	EA	DS002,DS003,DS004,DS005,DS006,DS007,DS009,DS010
384 0664 000	LED YELLOW ESD	1	EA	DS001
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	7	EA	CR033,CR034,CR036,CR037,CR041,CR054,CR057
384 0838 000	TRANSZORB 1N6380 36V 5W ESD	2	EA	CR049,CR050
386 0016 000	ZENER 1N2974A 10V 10W 10% ESD	1	EA	CR055
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	4	EA	CR018,CR020,CR022,CR039
386 0100 000	ZENER, 1N4747A 20V ESD	4	EA	CR019,CR023,CR032,CR040
386 0123 000	ZENER, 1N4732A 4.7V ESD	1	EA	CR001
386 0425 000	ZENER 1N2974(R) 10V 10W ESD	1	EA	CR056
398 0020 000	FUSE, FAST CART 3A 250V	1	EA	F004
398 0021 000	FUSE, FAST CART 4A 250V	1	EA	F002
398 0022 000	FUSE, FAST CART 5A 250V	1	EA	F003
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F005,F006
402 0129 000	CLIP, 1/4 DIA FUSE	6	EA	XF002,XF003,XF004
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	XF001,XF005,XF006
404 0509 000	SOCKET, DIP, 28 PIN (DL)	4	EA	XU005,XU006,XU025,XU026
404 0513 000	HEAT SINK PA1-1CB	2	EA	#U043,#U046
404 0673 000	SOCKET, DIP, 8 PIN (DL)	17	EA	XU007,XU008,XU009,XU010,XU011,XU012,XU013,XU014,XU023,XU024,XU027,XU028,XU029,XU030,XU031,XU032,XU047
404 0674 000	SOCKET, DIP, 14 PIN (DL)	11	EA	XU003,XU015,XU019,XU020,XU034,XU035,XU036,XU037,XU038,XU048,XU049
404 0675 000	SOCKET, DIP, 16 PIN (DL)	8	EA	XS007,XS008,XU044 XJP001 XJP002 XJP003 XJP004 XJP005
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8	EA	XU001,XU004,XU016,XU017,XU018,XU021,XU022,XU033
404 0790 000	HEATSINK, 8-PIN DIP	16	EA	#U007,#U008,#U009,#U010,#U011,#U012,#U013,#U014,#U023,#U024,#U027,#U028,#U029,#U030,#U031,#U032
404 0797 000	SOCKET, DIP, 24 PIN (DL)	1	EA	XU002
410 0382 000	INSULATOR #4 SCREW	2	EA	#U042
410 0385 000	INSULATOR TO-3 SILICON	1	EA	#U042
410 0440 000	INSULATOR PAD FOR TO-247,	2.0	EA	#U043,#U046
494 0196 000	CHOKE RF 100UH	2	EA	L001,L002
500 0753 000	CAP, MICA, 56PF 500V 5%	3	EA	C039,C065,C066
500 0837 000	CAP, MICA, 510PF 500V 5%	1	EA	C069
500 0845 000	CAP, MICA, 2000PF 500V 5%	1	EA	C067
506 0235 000	CAP .0033UF 100V 5%	32	EA	C020,C021,C022,C026,C028,C030,C032,C034,C036,C038,C040,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107,C108,C109,C112,C113,C114
516 0453 000	CAP .1UF 100V 20% X7R	77	EA	C013,C014,C015,C016,C023,C024,C041,C042,C043,C044,C045,C046,C047,C048,C049,C051,C054,C057,C059,C061,C062,C063,C068,C070,C073,C076,C077,C080,C081,C082,C083,C086,C087,C090,C091,C111,C115,C116,C117,C118,C119,C120,C121,C122,C123,C124,C125,C126,C127,C128,C129,C130,C131,C132,C133,C134,C135,C136,C137,C138,C139,C140,C141,C147,C148,C149,C151,C152,C153,C154,C156,C157,C158,C159,C160,C163,C165
516 0511 000	CAP 0.47UF 100V 20%	1	EA	C164
516 0530 000	CAP .01UF 10% 100V X7R	15	EA	C001,C002,C003,C004,C009,C010,C011,C012,C056,C142,C143,C144,C145,C146,C162
522 0550 000	CAP 100UF 25V 20%	7	EA	C052,C058,C060,C064,C072,C155,C161
526 0050 000	CAP 1UF 35V 20%	16	EA	C005,C006,C007,C008,C017,C018,C019,C071,C074,C075,C078,C079,C084,C085,C0 88,C089
526 0108 000	CAP 4.7UF 35V 20%	1	EA	C055
526 0109 000	CAP 22UF 25V 20%	1	EA	C110

WARNING: Disconnect primary power prior to servicing.

540 1380 000	RES NETWORK 10K OHM 2%	8	EA	R020,R038,R049,R053,R097,R118,R135,R205
540 1386 000	RES NETWORK 10K OHM 2%	4	EA	R025,R029,R035,R040
540 1430 000	RES NETWORK, 10K OHM 2%	4	EA	R012,R028,R034,R062
540 1443 000	RES NETWORK 27 OHM 2%	2	EA	R021,R022
540 1493 000	RES NETWORK 100K OHM	2	EA	R051,R052
540 1496 000	RES NETWORK 100 OHM	4	EA	R044,R045,R046,R054
540 1600 115	RES 39 OHM 3W 5%	32	EA	R001,R004,R006,R013,R024,R031,R037,R043,R047,R064,R066,R068,R071,R074,R076,R078,R079,R082,R136,R179,R180,R182,R184,R187,R188,R191,R193,R195,R196,R197,R198,R199
540 1600 201	RES 100 OHM 3W 5%	28	EA	R008,R009,R010,R011,R027,R033,R041,R063,R065,R067,R069,R070,R072,R073,R075,R077,R080,R081,R112,R147,R181,R183,R185,R186,R189,R190,R192,R194
540 1600 203	RES 120 OHM 3W 5%	1	EA	R003
540 1600 204	RES 130 OHM 3W 5%	1	EA	R005
540 1600 205	RES 150 OHM 3W 5%	2	EA	R002,R007
540 1600 208	RES 200 OHM 3W 5%	2	EA	R166,R168
542 0051 000	RES 3 OHM 5% 12W	3	EA	R132,R133,R211
542 1600 000	RES 0.1 OHM 5W 5%	1	EA	R144
544 1662 000	RES 30 OHM 20W 2% TO-220	1	EA	R115
548 2400 030	RES 2 OHM 1/2W 1%	1	EA	R145
548 2400 185	RES 75 OHM 1/2W 1%	3	EA	R105,R110,R114
548 2400 201	RES 100 OHM 1/2W 1%	2	EA	R143,R171
548 2400 219	RES 154 OHM 1/2W 1%	1	EA	R125
548 2400 230	RES 200 OHM 1/2W 1%	1	EA	R226
548 2400 251	RES 332 OHM 1/2W 1%	6	EA	R059,R092,R093,R094,R095,R096
548 2400 258	RES 392 OHM 1/2W 1%	5	EA	R116,R155,R163,R172,R212
548 2400 266	RES 475 OHM 1/2W 1%	2	EA	R085,R138
548 2400 269	RES 511 OHM 1/2W 1%	2	EA	R139,R169
548 2400 281	RES 681 OHM 1/2W 1%	2	EA	R126,R156
548 2400 285	RES 750 OHM 1/2W 1%	1	EA	R124
548 2400 301	RES 1K OHM 1/2W 1%	11	EA	R016,R050,R055,R056,R057,R058,R060,R083,R084,R146,R152
548 2400 321	RES 1.62K OHM 1/2W 1%	1	EA	R221
548 2400 330	RES 2K OHM 1/2W 1%	2	EA	R157,R161
548 2400 334	RES 2.21K OHM 1/2W 1%	4	EA	R014,R158,R200,R202
548 2400 339	RES 2.49K OHM 1/2W 1%	1	EA	R222
548 2400 347	RES 3.01K OHM 1/2W 1%	1	EA	R107
548 2400 351	RES 3.32K OHM 1/2W 1%	3	EA	R099,R102,R103
548 2400 366	RES 4.75K OHM 1/2W 1%	1	EA	R203
548 2400 385	RES 7.5K OHM 1/2W 1%	1	EA	R130
548 2400 389	RES 8.25K OHM 1/2W 1%	2	EA	R201,R207
548 2400 401	RES 10K OHM 1/2W 1%	37	EA	R015,R017,R018,R019,R023,R061,R088,R091,R098,R117,R120,R122,R123,R127,R128,R137,R149,R153,R154,R159,R160,R165,R167,R175,R176,R177,R178,R204,R206,R208,R216,R218,R219,R220,R223,R224,R225
548 2400 413	RES 13.3K OHM 1/2W 1%	1	EA	R129
548 2400 430	RES 20K OHM 1/2W 1%	1	EA	R100
548 2400 434	RES 22.1K OHM 1/2W 1%	2	EA	R140,R142
548 2400 438	RES 24.3K OHM 1/2W 1%	1	EA	R131
548 2400 440	RES 25.5K OHM 1/2W 1%	1	EA	R104
548 2400 451	RES 33.2K OHM 1/2W 1%	4	EA	R086,R089,R101,R119
548 2400 458	RES 39.2K OHM 1/2W 1%	1	EA	R164
548 2400 469	RES 51.1K OHM 1/2W 1%	2	EA	R148,R151
548 2400 501	RES 100K OHM 1/2W 1%	8	EA	R109,R113,R141,R209,R210,R214,R215,R217
548 2400 512	RES 130K OHM 1/2W 1%	4	EA	R087,R090,R106,R121
548 2400 589	RES 825K OHM 1/2W 1%	2	EA	R108,R111
548 2400 601	RES 1MEG OHM 1/2W 1%	4	EA	R134,R170,R173,R174

WARNING: Disconnect primary power prior to servicing.

550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1	EA	R150
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	1	EA	R213
600 0579 000	SW, ROTARY 4PDT	2	EA	S007,S008
604 0905 000	SW, PB MOMENTARY	1	EA	S006
610 0870 000	PLUG, NON-INS SHORTING	34	EA	#P001B,#P002,#P003,#P004,#P010
610 0900 000	HEADER 3 CKT STRAIGHT	2	EA	XP005,XP006
610 0980 000	*HDR 20C RT ANG 2ROW TOP LATCH	4	EA	J001,J002,J003,J004
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	1	EA	J009
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J008
610 1054 000	HEADER STRAIGHT MNT 8 PIN	1	EA	J006
610 1098 000	HDR, 4 PIN IN-LINE	2	EA	J012,J013
610 1106 000	HDR, 8PIN, 1ROW, STRT,POL	1	EA	J007
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J005
612 0904 000	JACK, PC MT GOLD PLATED	1	EA	P011
612 1176 000	DIP STRIP, FEMALE 10 POS	4	EA	P001B,P002,P003,P004
612 1184 000	SHUNT JUMPER 0.1" CENTERS	2	EA	P005,P006
612 1369 000	JACK, PCB MT, .051 PIN	10	EA	XU042,XU045
839 7930 011	SCHEM, MOD ENCODER	0		
839 7930 105	MOD ENCODER HS	1		
843 5155 011	PWB, MOD ENCODER	1		
917 2150 054	FIRMWARE, MOD ENCODER	5	EA	JP001,JP002,JP003,JP004,JP005
917 2150 803	4 PIN PLUG, JUMPER PIN1-2, 3-4	1.0	EA	P012
917 2210 012	CLIP 8.0 FIRMWARE	1	EA	
917 2210 016	ROM 8.0 FIRMWARE	4	EA	U005,U006,U025,U026
917 2542 001	ASSY, AIR SENSOR	1	EA	#R115,U041
999 2660 002	HARDWARE LIST	1	EA	

Table 7-15. BUFFER AMP BD - 992 8196 001 (J)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	5	EA	TP001,TP002,TP003,TP004,TP005
380 0728 000	XSTR, NMOS IRL520 ESD	4	EA	Q001,Q002,Q003,Q004
382 1204 000	IC TC4423 ESD	2	EA	U001,U002
384 0612 000	DIODE 1N3070 ESD	4	EA	CR002,CR004,CR007,CR009
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	2	EA	DS002,DS004
384 0662 000	LED RED ESD	4	EA	DS001,DS003,DS005,DS006
384 0802 000	TRANSZORB, BIPOLAR 18V 5% ESD	4	EA	CR003,CR005,CR008,CR010
386 0085 000	ZENER, 1N4740A 10V ESD	1	EA	CR015
386 0297 000	ZENER 1N5338B 5.1V 5W 5% ESD	6	EA	CR001,CR006,CR011,CR012,CR013,CR014
398 0019 000	FUSE, FAST CART 2A 250V	2	EA	F003,F004
398 0021 000	FUSE, FAST CART 4A 250V	2	EA	F001,F002
402 0129 000	CLIP, 1/4 DIA FUSE	8	EA	2#F001 2#F002 2#F003 2#F004
404 0513 000	HEAT SINK PA1-1CB	4	EA	#Q001,#Q002,#Q003,#Q004
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2	EA	XU001,XU002
494 0377 000	CHOKE RF 0.27UH	2	EA	L001,L003
494 0378 000	CHOKE 0.33UH 10% 780MA	2	EA	L002,L004
506 0233 000	CAP, 0.1UF 63V 5%	4	EA	C008,C010,C018,C020
506 0246 000	CAP, 0.47UF 63V 5%	6	EA	C002,C004,C006,C012,C014,C016
508 0378 000	CAP .22 UF 100V 10%	2	EA	C009,C019
516 0081 000	CAP, DISC .01UF 1KV 20%	4	EA	C003,C005,C013,C015
522 0566 000	CAP 100UF 63V 20%	2	EA	C001,C011
526 0342 000	CAP 2.7UF 35V 10%	2	EA	C007,C017
540 1600 017	RES 4.7 OHM 3W 5%	8	EA	R010,R013,R015,R020,R026,R029,R031,R036
540 1600 101	RES 10 OHM 3W 5%	6	EA	R009,R012,R014,R025,R028,R030
540 1600 316	RES 4.3K OHM 3W 5%	2	EA	R005,R021

WARNING: Disconnect primary power prior to servicing.

540 1600 401	RES 10K OHM 3W 5%	4	EA	R001,R002,R003,R004
542 0051 000	RES 3 OHM 5% 12W	2	EA	R007,R023
542 0062 000	RES 200 OHM 5% 12W	4	EA	R006,R022,R037,R038
546 0313 000	RES 50 OHM 5W 5%	1	EA	R016
548 2400 101	RES 10 OHM 1/2W 1%	4	EA	R011,R019,R027,R035
548 2400 201	RES 100 OHM 1/2W 1%	4	EA	R008,R018,R024,R034
839 7930 014	SCHEM, BUFFER AMP	0		
843 5155 014	PWB, BUFFER AMP	1		
939 5695 054	TRANSFORMER, TOROID	2	EA	T001,T002
999 2629 001	HARDWARE LIST	1	EA	

Table 7-16. PWA, RF SPLITTER, ESD SAFE - 992 8201 001 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
414 0310 000	TOROID, FERRITE	2	EA	
610 0998 000	HDR, 6 PIN, PC BD	1	EA	J021
610 1086 000	HDR 34 PIN/ACTION PINS	20	EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014 ,J015,J016,J017,J018,J019,J020
610 1088 000	LATCH .576 FOR EJECTION	40	EA	2#J001 2#J002 2#J003 2#J004 2#J005 2#J006 2#J007 2#J008 2#J009 2#J010 2#J011 2#J012 2#J013 2#J014 2#J015 2#J016 2#J017 2#J018 2#J019 2#J020
817 2099 044	TRANSFORMER STAPLE	24		
843 5155 005	PWB, RF SPLITTER	1		

Table 7-17. PAC CABLE PKG FA - 992 8354 002 (N)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
917 2150 796	POWER CABLE,	1	EA	#A56
922 0999 659	CABLE DRIVER BINARY	1	EA	
929 9009 153	DOOR RESTRAINT	5	EA	
943 5155 670	CABLE SYNTH/OSC INTERFACE	1	EA	
943 5155 682	RIBBON CABLES	1	EA	
943 5155 814	TEMP SENSOR CABLE	1	EA	
952 9180 004	UPPER FUSE BD CABLE	2	EA	
952 9180 005	LOWER FUSE BD CABLE	3	EA	
952 9180 007	ENCODER CABLES	1	EA	
952 9180 502	PA BLOWERS CABLE	3	EA	
952 9180 503	MAIN CABLE	1	EA	
952 9180 506	ENC INTERCONNECT CABLE	1	EA	
952 9180 507	EFF.COIL CABLE	1	EA	
952 9180 510	PAC INTERLOCK CABLE	1	EA	
952 9180 532	PAC LED CABLES	1	EA	

Table 7-18. AIR FLOW MONITOR - 992 8363 001 (H)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
356 0084 000	CABLE TY RAP	1.0	EA	TO BE MODIFIED BY 'OP' INSTRUCTION SHEETS AND USED AS A WASHER
382 0428 000	IC, LM358 ESD	1	EA	U003
382 1199 000	IC, LM35 ESD	1	EA	U002
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1	EA	XU003
516 0453 000	CAP .1UF 100V 20% X7R	6	EA	C001,C002,C003,C006,C007,C008
526 0050 000	CAP 1UF 35V 20%	2	EA	C004,C005
544 1662 000	RES 30 OHM 20W 2% TO-220	1	EA	R001

WARNING: Disconnect primary power prior to servicing.

548 2400 142	RES 26.7 OHM 1/2W 1%	1	EA	R008
548 2400 185	RES 75 OHM 1/2W 1%	2	EA	R004,R005
548 2400 501	RES 100K OHM 1/2W 1%	2	EA	R003,R006
548 2400 589	RES 825K OHM 1/2W 1%	2	EA	R002,R007
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	1	EA	J001
839 7930 022	SCHEM, AIR FLOW MON	0		
843 5155 022	PWB, AIR FLOW MON.	1		
917 2542 001	ASSY, AIR SENSOR	1	EA	#R001,U001
999 2657 001	HARDWARE LIST	1	EA	

Table 7-19. PWA, DRIVER MOTHERBD, ESD SAFE - 992 8538 001 (U)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0257 000	NUT, CAPTIVE 6-32.	4	EA	
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16	EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2	EA	
358 3093 000	STUD, BRS 6-32 X 1/2.	16	EA	
358 3164 000	CARD GUIDE	32	EA	2#J001 2#J002 2#J003 2#J004 2#J005 2#J006 2#J007 2#J008 2#J009 2#J010 2#J011 2#J012 2#J013 2#J014 2#J015 2#J016
384 0431 000	RECT. 1N4001 ESD	1	EA	CR007
384 0612 000	DIODE 1N3070 ESD	3	EA	CR001,CR003,CR005
494 0392 000	CHOKE RF 4.70UH	1	EA	L003
494 0404 000	CHOKE RF 33.0UH	2	EA	L001,L002
500 0852 000	CAP, MICA, 1000PF 500V 5%	1	EA	C011
500 0903 000	CAP, MICA, 2700PF 500V 5%	2	EA	C012,C013
508 0562 000	CAP, 1.0UF +/- 10% 400VDC	1	EA	C007
516 0453 000	CAP .1UF 100V 20% X7R	3	EA	C009,C010,C014
522 0630 000	CAP 100 UF 400V 20%	7	EA	C001,C002,C003,C004,C005,C006,C008
540 1600 207	RES 180 OHM 3W 5%	2	EA	R011,R012
540 1600 422	RES 75K OHM 3W 5%	4	EA	R001,R002,R003,R004
548 1505 000	RES .2 OHM 10 W 1%	1	EA	R020
548 2400 201	RES 100 OHM 1/2W 1%	1	EA	R013
548 2400 335	RES 2.26K OHM 1/2W 1%	2	EA	R005,R006
548 2400 391	RES 8.66K OHM 1/2W 1%	2	EA	R022,R023
548 2400 401	RES 10K OHM 1/2W 1%	3	EA	R015,R017,R019
548 2400 501	RES 100K OHM 1/2W 1%	3	EA	R014,R016,R018
548 2400 601	RES 1MEG OHM 1/2W 1%	11	EA	R007,R009,R021,R024,R025,R026,R027,R028,R030,R031,R032
548 2400 630	RES 2MEG OHM 1/2W 1%	3	EA	R008,R010,R029
574 0472 000	RELAY SPDT 12VDC 10A	2	EA	K001,K002
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	2.0	EA	J031,J034
610 1051 000	HOUSING 28 DUAL POSITIONS.	16	EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4	EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8	EA	2#J25 2#J26 2#J27 2#J28
610 1106 000	HDR, 8PIN, 1ROW, STRT,POL	2	EA	J029,J032
610 1141 000	HEADER 10 POS RIGHT ANGLE	8	EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	30	EA	P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072,P073,P074,P081,P082,P083,P084
620 0515 000	RECP, SCREW ON SMC	1	EA	J030
620 1677 000	RECEPTACLE, PC MT, BNC.	1	EA	J033
817 2150 053	STRAP	2		
822 0922 109	STDOFF,.25 X 5.35 X 4-40	2		
822 0999 017	SUPPORT, COMBINER COVER	2		

WARNING: Disconnect primary power prior to servicing.

839 7930 504	SCHEM, COMBINER MB,DRIVER	0		
843 5155 504	PWB, COMBINER MB, DRIVER	1		
917 2150 603	SPACER	16	EA	
922 0922 156	TRANSFORMER	2	EA	T020
922 0999 598	STANDOFF	16	EA	
922 0999 617	XFMR PAIR	6	EA	T3/T14 T4/T13 T5/T12 T6/T11 T7/T10 T8/T9
922 0999 618	XFMR PAIR	2	EA	T1/T16 T2/T15
922 0999 625	DRIVER RF COND SUPPORT	3	EA	
999 2717 001	HARDWARE LIST	1	EA	

Table 7-20. EFFICIENCY COIL OCTAL,ESD SAFE - 992 8539 002 (E1)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
051 0001 023	*ADHESIVE, DP-190 GRAY	0	EA	
2520247000A	*WIRE, STRD 18AWG YEL	16	FT	
356 0082 000	CABLE TIE TY RAP	4	EA	
384 0357 000	RECTIFIER 1N4004 ESD	2	EA	CR001,CR002
492 0774 000	COIL AIR-WOUND	8	EA	L001,L002,L003,L004,L005,L006,L007,L008
516 0453 000	CAP .1UF 100V 20% X7R	6	EA	C001,C002,C003,C004,C005,C006
574 0492 000	RELAY DPDT 24VDC 10ADC	8	EA	K001,K002,K003,K004,K005,K006,K007,K008
610 1107 000	HDR,12PIN,1ROW,STRT,POL	2	EA	J001,J002
612 1376 000	JACK, PANEL MOUNT BANANA	16	EA	J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016,J017,J018
839 7930 503	SCHEM, EFF COIL BOARD	0		
843 5155 503	PWB, EFFICIENCY COIL	1		
939 7930 605	EFF COIL SUPPORT PLATE	1	EA	

Table 7-21. EFFICIENCY COIL OCTAL,ESD SAFE - 992 8539 003 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
051 0001 023	*ADHESIVE, DP-190 GRAY	0	EA	
2520247000A	*WIRE, STRD 18AWG YEL	16	FT	
356 0082 000	CABLE TIE TY RAP	4	EA	
384 0357 000	RECTIFIER 1N4004 ESD	2	EA	CR001,CR002
492 0774 000	COIL AIR-WOUND	8	EA	L001,L002,L003,L004,L005,L006,L007,L008
516 0453 000	CAP .1UF 100V 20% X7R	6	EA	C001,C002,C003,C004,C005,C006
574 0492 000	RELAY DPDT 24VDC 10ADC	4	EA	K001,K003,K005,K007
610 1107 000	HDR,12PIN,1ROW,STRT,POL	2	EA	J001,J002
612 1376 000	JACK, PANEL MOUNT BANANA	16	EA	J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014,J015,J016,J017,J018
843 5155 503	PWB, EFFICIENCY COIL	1		
843 5155 843	SCHEM, EFF COIL BOARD	0		
939 7930 605	EFF COIL SUPPORT PLATE	1	EA	

Table 7-22. PWA, MAIN MOTHERBD, ESD SAFE - 992 8548 001 (R)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
200000000000000024	SCR, #4 X 5/8 PPH SELF-TAP	32	EA	2#J001,2#J002,2#J003,2#J004,2#J005,2#J006,2#J007,2#J008,2#J009,2#J010,2#J011,2#J012,2#J013,2#J014,2#J015,2#J016
324 0257 000	NUT, CAPTIVE 6-32	4	EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16	EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2	EA	
358 3093 000	STUD, BRS 6-32 X 1/2	16	EA	
358 3164 000	CARD GUIDE	32	EA	

WARNING: Disconnect primary power prior to servicing.

				2#J001 2#J002 2#J003 2#J004 2#J005 2#J006 2#J007 2#J008 2#J009 2#J010 2#J011 2#J012 2#J013 2#J014 2#J015 2#J016
522 0630 000	CAP 100 UF 400V 20%	8	EA	C001,C002,C003,C004,C005,C006,C007,C008
540 1600 422	RES 75K OHM 3W 5%	4	EA	R001,R002,R003,R004
610 1051 000	HOUSING 28 DUAL POSITIONS	16	EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014 ,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4	EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8	EA	2#J25 2#J26 2#J27 2#J28
610 1141 000	HEADER 10 POS RIGHT ANGLE	8	EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	32	EA	P011,P012,P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041 ,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072 ,P073,P074,P081,P082,P083,P084
822 0922 109	STDOFF,.25 X 5.35 X 4-40	2		
822 0999 017	SUPPORT, COMBINER COVER	2		
839 7930 505	SCHEM, COMBINER MB, MAIN	0		
843 5155 505	PWB, COMBINER MB, MAIN	1		
917 2150 603	SPACER	16	EA	
922 0999 100	XFMR PAIR	8	EA	T1/T16 T2/T15 T3/T14 T4/T13 T5/T12 T6/T11 T7/T10 T8/T9
922 0999 598	STANDOFF	16	EA	
922 0999 624	RF COND SUPPORT	3	EA	

Table 7-23. PWA, BINARY MOTHERBD, ESD SAFE - 992 8549 001 (N)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
324 0257 000	NUT, CAPTIVE 6-32	4	EA	
358 2714 000	STUD, PC BD 6-32 X 3/8	16	EA	
358 2837 000	STUD, PC BD 4-40 X 5/16	2	EA	
358 3093 000	STUD, BRS 6-32 X 1/2	16	EA	
358 3164 000	CARD GUIDE	32	EA	2#J001 2#J002 2#J003 2#J004 2#J005 2#J006 2#J007 2#J008 2#J009 2#J010 2#J011 2#J012 2#J013 2#J014 2#J015 2#J016
522 0630 000	CAP 100 UF 400V 20%	8	EA	C001,C002,C003,C004,C005,C006,C007,C008
540 1600 422	RES 75K OHM 3W 5%	6	EA	R001,R002,R003,R004,R005,R006
610 1005 000	PLUG, SHORTING .040 PINS	4	EA	P030,P031,P032,P033
610 1051 000	HOUSING 28 DUAL POSITIONS	16	EA	J001,J002,J003,J004,J005,J006,J007,J008,J009,J010,J011,J012,J013,J014 ,J015,J016
610 1084 000	HDR 10 PIN/ACTION PINS	4	EA	J025,J026,J027,J028
610 1088 000	LATCH .576 FOR EJECTION	8	EA	2#J25 2#J26 2#J27 2#J28
610 1141 000	HEADER 10 POS RIGHT ANGLE	8	EA	J017,J018,J019,J020,J021,J022,J023,J024
610 1143 000	PLUG, RIVET TYPE BANANA	32	EA	P011,P012,P013,P014,P021,P022,P023,P024,P031,P032,P033,P034,P041 ,P042,P043,P044,P051,P052,P053,P054,P061,P062,P063,P064,P071,P072 ,P073,P074,P081,P082,P083,P084
612 1012 000	JACK PC MT .040 PINS	16	EA	4#J30 4#J31 4#J32 4#J33
817 2150 024	JUMPER	2		
822 0922 109	STDOFF,.25 X 5.35 X 4-40	2		
822 0999 017	SUPPORT, COMBINER COVER	2		
839 7930 506	SCHEM, COMBINER MB,BINARY	0		
843 5155 506	PWB, COMBINER MB, BINARY	1		
917 2150 603	SPACER	16	EA	
922 0999 598	STANDOFF	16	EA	
922 0999 624	RF COND SUPPORT	3	EA	
992 8360 001	XFMR PKG	1	EA	
999 2718 001	HARDWARE LIST	1	EA	

WARNING: Disconnect primary power prior to servicing.

Table 7-24. PRE DRIVER TUNING BD, - 992 8604 001 (E2)

Harris PN	Description	QTY	UM	Reference Designators
051 0001 023	*ADHESIVE, DP-190 GRAY	0	EA	#L001,#L002,#L003
2520247000A	*WIRE, STRD 18AWG YEL	2	FT	#L001,#L002,#L003
2540004000A	*WIRE, BUS CU 16AWG	1	FT	#C007,#C008,#C009,#JP002
354 0010 000	LUG #10 RING BLU 16-14AWG	3	EA	#C007,#C008,#C009
402 0189 000	CLIP, ADJ COIL 12AWG MAX	5	EA	
504 0267 000	CAP 2000PF 5KV 5% (272)	1	EA	C007
504 0368 000	CAP 3000PF 3 KV 5% (272)	2	EA	C008,C009
516 0453 000	CAP .1UF 100V 20% X7R	6	EA	C001,C002,C003,C004,C005,C006
574 0492 000	RELAY DPDT 24VDC 10ADC	6	EA	K001,K002,K003,K004,K005,K006
610 0947 000	RECP, D, 15 PIN, RT ANG	1	EA	J001
610 1098 000	HDR, 4 PIN IN-LINE	1	EA	J003
614 0727 000	TERM BD 8C 1ROW PC MT	1	EA	TB001
620 1677 000	RECEPTACLE, PC MT, BNC	1	EA	J002
839 7930 511	SCHEMATIC, PRE-DRIVER	0		
843 5155 511	PWB, PRE-DRIVER TUNING	1		
922 0999 612	COIL MODIFICATION	3	EA	L001,L002,L003
999 2709 001	HARDWARE LIST	1	EA	

Table 7-25. DRIVER TUNING ASSY - 992 8605 002 (A)

Harris PN	Description	QTY	UM	Reference Designators
358 1214 000	SCREWLOCK, FEMALE	1	EA	
448 0224 000	HANDLE ALUM	2	EA	
504 0075 000	CAP .003UF 6KV 5%	1	EA	C006
504 0094 000	CAP .006UF 5KV 5%	1	EA	C005
504 0441 000	CAP 11,000PF 8KV 5% (293)	1	EA	C004
504 0446 000	CAP 12,000PF 5KV 5% (293)	2	EA	C001B,C001C
504 0447 000	CAP 13,000PF 5KV 5% (293)	1	EA	C001A
504 0523 000	CAP 22000PF 5KV 5%	1	EA	C003
504 0525 000	CAP, MICA, .039UF 5KV 5%	1	EA	C002
580 0010 000	RELAY, VAC SPDT 26.5VDC	5	EA	K003A,K003B,K004,K005,K006 HAD TO DOUBLE UP ON K3 DUE TO THE CURRENT THRU C3. C2 WAS HARD WIRED INTO THE CIRCUIT
917 2150 572	CAP GND STUD	6	EA	C002,C003,C004 3#C001
917 2150 573	SUPPORT BLOCK	7	EA	#L001
917 2150 577	CAP GND STUD	2	EA	#C005,#C006
917 2150 624	STDOFF,0.50 X 1.70 X10-32	2	EA	
922 0999 507	NUT BUSHING	1	EA	
922 0999 589	DRVR BOX CTR COND CONN	1	EA	
922 0999 590	DRVR COND MTG BLOCK BOX	1	EA	
922 0999 610	COIL	1	EA	L004
922 0999 611	STRAP	1	EA	
922 0999 673	TUBING STRAP	1	EA	L4TOP-L2L3PLT
929 8305 421	COIL ASSY, 6 TURNS	2	EA	L005,L006
929 8305 649	BAR MOD	4	EA	#L005,#L006 2#L004
939 7930 631	PLATE	1	EA	
939 7930 632	CAP PLATE	1	EA	
939 7930 633	SHORT DIVIDER	1	EA	
939 7930 634	RELAY BOX TOP	1	EA	
939 7930 635	COIL STRAP	1	EA	L001
939 7930 636	COIL STRAP	1	EA	L001
939 7930 637	COIL STRAP	1	EA	L001
939 7930 638	COIL STRAP	1	EA	L001

WARNING: Disconnect primary power prior to servicing.

939 7930 639	COIL STRAP	1	EA	L001
939 7930 641	COIL MTG BRKT	1	EA	#L006
939 7930 642	CONN BRKT	1	EA	
939 8127 001	STRAP	1	EA	L6BTM-L2L3PLT
939 8127 002	STRAP	1	EA	L5BTM-L2L3PLT
939 8127 003	STRAP	1	EA	L5CT-K5NC
939 8127 004	STRAP	1	EA	K5C-C1PLT
939 8127 005	STRAP	1	EA	K5NO-C5
939 8127 006	STRAP	3	EA	K2ANC-L2 K2BNC-L2 K3NC-L3
939 8127 009	STRAP	4	EA	K3ANO-K3BNO
939 8127 010	STRAP	1	EA	K3C-C1PLT
939 8127 011	STRAP	1	EA	K6C-C1PLT
939 8127 012	STRAP	1	EA	K4C-C1PLT
939 8127 013	STRAP	1	EA	K4NO-C4
939 8127 014	STRAP	1	EA	K4NC-L4CT
943 5155 635	DRVR BOX SIDE PNL	2	EA	
943 5155 636	DRVR BOX TOP	1	EA	
943 5155 637	DRVR BOX END PNL	2	EA	
943 5155 638	DRVR BOX BASE	1	EA	
943 5155 671	RELAY BOX LT SIDE	1	EA	
943 5155 672	RELAY BOX RT SIDE	1	EA	
943 5155 673	LONG DIVIDER	1	EA	
943 5155 683	DRVR TUNING CABLE	1	EA	
994 7784 002	COIL CLIP 3/8 RIBBON	2	EA	
994 7784 003	COIL CLIP 1/2 RIBBON	1	EA	

Table 7-26. ANALOG INPUT BD. - 992 8882 001 (T)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	41	EA	TP001,TP002,TP003,TP004,TP005,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033,TP034,TP035,TP036,TP037,TP038,TP039,TP040,TP041,TP042
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP011,JP013
380 0125 000	XSTR, NPN 2N4401 ESD	3	EA	Q001,Q002,Q003
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U022
382 0359 000	IC, 7815 ESD	1	EA	U024
382 0360 000	IC, 7915 ESD	1	EA	U023
382 0463 000	IC, 4051/14051 ESD	1	EA	U012
382 0594 000	*IC TL074ACN ESD	3	EA	U009,U011,U027
382 0648 000	IC, LM339A ESD	1	EA	U013
382 0676 000	IC, 74LS05N ESD	2	EA	U014,U026
382 0711 000	*PRECISION IC MULTIPLIER ESD	1	EA	U016
382 0742 000	IC AD7524 ESD	1	EA	U018
382 0749 000	IC NE5532A ESD	7	EA	U001,U002,U003,U004,U007,U008,U010
382 0774 000	IC 74HC14 ESD	1	EA	U025
382 0867 000	IC, 4053BC ESD	1	EA	U017
382 0882 000	IC, 78L05A ESD	1	EA	U029
382 1011 000	IC, 14541/4541 ESD	1	EA	U028
382 1084 000	IC, LP339N ESD	1	EA	U015
384 0321 000	*DIODE 5082-2800 ESD	4	EA	CR004,CR028,CR030,CR031
384 0431 000	RECT. 1N4001 ESD	5	EA	CR017,CR018,CR019,CR020,CR027
384 0612 000	DIODE 1N3070 ESD	9	EA	CR006,CR007,CR012,CR013,CR022,CR023,CR024,CR025,CR026
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	3	EA	DS001,DS002,DS003
384 0662 000	LED RED ESD	2	EA	DS004,DS005

WARNING: Disconnect primary power prior to servicing.

384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR015
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	2	EA	CR016,CR021
384 0731 000	* DIODE, SWITCHING 1N4607 ESD	1	EA	CR003
384 0799 000	DIODE, BIPOLAR ESD	2	EA	CR009,CR010
386 0123 000	ZENER, 1N4732A 4.7V ESD	1	EA	CR014
386 0135 000	ZENER, 1N4733A 5.1V ESD	3	EA	CR001,CR002,CR011
386 0427 000	ZENER LM-313H 1.22VDC ESD	1	EA	CR029
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	2XF001 2XF002 2XF003
404 0513 000	HEAT SINK PA1-1CB	3	EA	#U022,#U023,#U024
404 0673 000	SOCKET, DIP, 8 PIN (DL)	7	EA	XU001,XU002,XU003,XU004,XU007,XU008,XU010
404 0674 000	SOCKET, DIP, 14 PIN (DL)	9	EA	XU009,XU011,XU013,XU014,XU015,XU025,XU026,XU027,XU028
404 0675 000	SOCKET, DIP, 16 PIN (DL)	3	EA	XU012,XU017,XU018
404 0797 000	SOCKET, DIP, 24 PIN (DL)	5	EA	XU005,XU006,XU019,XU020,XU021
494 0415 000	CHOKE RF 470.0UH	2	EA	L005,L006
494 0418 000	CHOKE RF 820.0UH	2	EA	L007,L008
500 0844 000	CAP, MICA, 1000PF 100V 5%	3	EA	C004,C010,C053
500 0845 000	CAP, MICA, 2000PF 500V 5%	2	EA	C054,C056
506 0230 000	CAP .001UF 100VAC 5%	1	EA	C050
506 0232 000	CAP, 0.01UF 100V 5%	8	EA	C002,C034,C038,C046,C057,C059,C063,C109
506 0236 000	CAP, 0.0047UF 100V 5%	2	EA	C020,C021
506 0240 000	CAP, 0.033UF 100V 5%	2	EA	C022,C023
506 0246 000	CAP, 0.47UF 63V 5%	6	EA	C024,C025,C026,C027,C048,C049
516 0453 000	CAP .1UF 100V 20% X7R	48	EA	C006,C007,C016,C017,C018,C019,C035,C037,C045,C047,C058,C062,C066,C067,C071,C072,C073,C074,C075,C076,C077,C078,C079,C084,C085,C086,C087,C088,C089,C090,C091,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107,C108
516 0765 000	CAP 10PF 5% 100V C0G	10	EA	C003,C032,C033,C040,C041,C042,C044,C060,C061,C064
516 0774 000	CAP 56PF 5% 100V C0G	6	EA	C028,C029,C030,C031,C051,C055
516 0792 000	CAP NETWORK .1UF 10%	2	EA	C001,C008
522 0554 000	CAP 4.7UF 50V 20%	1	EA	C011
522 0561 000	CAP 100UF 63V 20%	4	EA	C065,C068,C069,C070
522 0570 000	CAP 2.2UF 50V 20%	3	EA	C012,C013,C014
526 0108 000	CAP 4.7UF 35V 20%	3	EA	C036,C039,C052
526 0321 000	CAP 3.3UF 15/16V 20%	1	EA	C009
526 0359 000	CAP 47UF 25V 10%	1	EA	C005
540 1380 000	RES NETWORK 10K OHM 2%	12	EA	R001,R002,R003,R010,R011,R014,R015,R016,R020,R021,R134,R152
540 1386 000	RES NETWORK 10K OHM 2%	2	EA	R013,R100
540 1386 000	RES NETWORK 10K OHM 2%	2	EA	R006,R028
540 1421 000	RES NETWORK 4700 OHM 2%	1	EA	R018
540 1496 000	RES NETWORK 100 OHM	5	EA	R005,R007,R008,R009,R012
540 1600 221	RES 680 OHM 3W 5%	1	EA	R096
540 1600 408	RES 20K OHM 3W 5%	1	EA	R095
548 2400 101	RES 10 OHM 1/2W 1%	2	EA	R034,R062
548 2400 143	RES 27.4 OHM 1/2W 1%	3	EA	R082,R098,R148
548 2400 205	RES 110 OHM 1/2W 1%	7	EA	R038,R039,R045,R048,R179,R180,R181
548 2400 218	RES 150 OHM 1/2W 1%	1	EA	R109
548 2400 247	RES 301 OHM 1/2W 1%	1	EA	R057
548 2400 251	RES 332 OHM 1/2W 1%	2	EA	R044,R047
548 2400 254	RES 357 OHM 1/2W 1%	2	EA	R090,R126
548 2400 258	RES 392 OHM 1/2W 1%	3	EA	R043,R046,R097
548 2400 269	RES 511 OHM 1/2W 1%	2	EA	R059,R147
548 2400 277	RES 619 OHM 1/2W 1%	1	EA	R078
548 2400 279	RES 649 OHM 1/2W 1%	1	EA	R159
548 2400 281	RES 681 OHM 1/2W 1%	2	EA	R049,R050

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548 2400 285	RES 750 OHM 1/2W 1%	3	EA	R053,R175,R176
548 2400 295	RES 953 OHM 1/2W 1%	1	EA	R165
548 2400 301	RES 1K OHM 1/2W 1%	4	EA	R022,R036,R156,R157
548 2400 312	RES 1.3K OHM 1/2W 1%	3	EA	R089,R131,R160
548 2400 330	RES 2K OHM 1/2W 1%	4	EA	R023,R084,R085,R105
548 2400 332	RES 2.1K OHM 1/2W 1%	1	EA	R094
548 2400 335	RES 2.26K OHM 1/2W 1%	1	EA	R086
548 2400 342	RES 2.67K OHM 1/2W 1%	1	EA	R122
548 2400 347	RES 3.01K OHM 1/2W 1%	2	EA	R027,R093
548 2400 351	RES 3.32K OHM 1/2W 1%	4	EA	R075,R081,R091,R141
548 2400 354	RES 3.57K OHM 1/2W 1%	1	EA	R061
548 2400 364	RES 4.53K OHM 1/2W 1%	1	EA	R158
548 2400 366	RES 4.75K OHM 1/2W 1%	1	EA	R074
548 2400 368	RES 4.99K OHM 1/2W 1%	1	EA	R110
548 2400 369	RES 5.11K OHM 1/2W 1%	2	EA	R037,R083
548 2400 373	RES 5.62K OHM 1/2W 1%	1	EA	R145
548 2400 389	RES 8.25K OHM 1/2W 1%	1	EA	R140
548 2400 401	RES 10K OHM 1/2W 1%	34	EA	R004,R030,R031,R032,R040,R041,R042,R060,R063,R064,R073,R077,R101,R112,R115,R117,R121,R123,R133,R136,R137,R138,R142,R146,R149,R150,R151,R154,R162,R163,R166,R167,R169,R177
548 2400 405	RES 11K OHM 1/2W 1%	1	EA	R103
548 2400 407	RES 11.5K OHM 1/2W 1%	1	EA	R024
548 2400 411	RES 12.7K OHM 1/2W 1%	1	EA	R132
548 2400 418	RES 15K OHM 1/2W 1%	3	EA	R055,R099,R124
548 2400 425	RES 17.8K OHM 1/2W 1%	2	EA	R092,R178
548 2400 430	RES 20K OHM 1/2W 1%	1	EA	R120
548 2400 434	RES 22.1K OHM 1/2W 1%	1	EA	R017
548 2400 438	RES 24.3K OHM 1/2W 1%	1	EA	R072
548 2400 439	RES 24.9K OHM 1/2W 1%	1	EA	R130
548 2400 442	RES 26.7K OHM 1/2W 1%	2	EA	R125,R153
548 2400 443	RES 27.4K OHM 1/2W 1%	1	EA	R135
548 2400 454	RES 35.7K OHM 1/2W 1%	1	EA	R058
548 2400 458	RES 39.2K OHM 1/2W 1%	1	EA	R071
548 2400 466	RES 47.5K OHM 1/2W 1%	1	EA	R102
548 2400 469	RES 51.1K OHM 1/2W 1%	1	EA	R116
548 2400 477	RES 61.9K OHM 1/2W 1%	1	EA	R139
548 2400 480	RES 66.5K OHM 1/2W 1%	1	EA	R164
548 2400 485	RES 75K OHM 1/2W 1%	2	EA	R106,R108
548 2400 489	RES 82.5K OHM 1/2W 1%	1	EA	R070
548 2400 493	RES 90.9K OHM 1/2W 1%	1	EA	R144
548 2400 501	RES 100K OHM 1/2W 1%	5	EA	R025,R079,R128,R129,R155
548 2400 520	RES 158K OHM 1/2W 1%	1	EA	R069
548 2400 547	RES 301K OHM 1/2W 1%	1	EA	R119
548 2400 566	RES 475K OHM 1/2W 1%	1	EA	R076
548 2400 581	RES 681K OHM 1/2W 1%	2	EA	R033,R114
548 2400 601	RES 1MEG OHM 1/2W 1%	8	EA	R051,R052,R087,R088,R107,R111,R127,R161
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	1	EA	R056
550 0914 000	POT, 10K OHM	2	EA	R065,R067
550 0941 000	POT 50K OHM 1/2W 20%	1.0	EA	R066
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	3	EA	R029,R054,R068
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2	EA	R113,R118
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	3	EA	R035,R104,R143
550 0961 000	TRIMPOT 50K OHM 1/2W 10%	1	EA	R173
550 0984 000	TRIMPOT 500K OHM 1/2W 10%	1.0	EA	R171
550 1070 000	TRIMPOT 100 OHM 1/2W 10%	2	EA	R019,R026

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604 1089 000	SW, TGL SPDT PC MOUNT	1	EA	S001
610 0900 000	HEADER 3 CKT STRAIGHT	5	EA	JP004,JP005,JP006,JP007,JP008
610 0979 000	*HDR 10C VERT 2ROW TOP LATCH	1	EA	J003
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	1	EA	J001
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J002
610 1070 000	HDR 6 PIN STRAIGHT	2	EA	JP001,JP002
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J004
610 1121 000	HDR 4C 2ROW STRAIGHT	1	EA	JP009
612 1184 000	SHUNT JUMPER 0.1" CENTERS	8	EA	#JP001,#JP002,#JP004,#JP005,#JP006,#JP007,#JP008,#JP009
839 7930 534	SCHEM, ANALOG INPUT BD	0		
843 5155 534	PWB, ANALOG INPUT BD	1		
917 2150 780	FIRMWARE, RAMP 1.0	1	EA	U006
917 2150 781	FIRMWARE, FB-COMP 1.0	1	EA	U005
917 2210 013	TRIM 8.0 FIRMWARE	3	EA	U019,U020,U021
999 2766 001	HARDWARE LIST, ANALOG	1	EA	

Table 7-27. OUTPUT NETWORK CABINET - 992 8519 002 (C)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
007 4030 023	BRZ, PH GND BAR 97-744-05	20	EA	
20000000000000794	CAP PLATE, TOP CONTACT	1	EA	#C001 WORKS FOR BOTH JENNINGS AND COMET STYLE CAPS
328 0070 000	WASHER CUPPED BLACK WEAR	4	EA	
328 0073 000	WASHER, RETAINER	4	EA	
336 1135 000	PIN, SPRING	3	EA	#C001
336 1137 000	PIN, SPRING	4	EA	
344 0017 000	SCREW, SET 10-32 X 3/16	4	EA	
358 3089 000	STANDOFF-MALE/FEMALE 6-32	3	EA	
358 3092 000	STUD, BRS 6-32 X 3/8	2	EA	#C007,#C008
358 3121 000	STUD, BRS 10-32 X 1	20	EA	
358 3131 000	STUD, BRS 1/4-20 X 1	20	EA	
358 3236 000	DRIVE, RIGHT ANGLE GEAR	1	EA	
358 3325 000	STUD 1/4 TURN PHILLIPS HD	4	EA	
398 0471 000	FUSE, TIME-DELAY, 1.5 AMP 500V	6	EA	
402 0004 000	CLIP, FUSE .812 60A 250V	4	EA	#GND HOOK
402 0130 000	FUSE HOLDER, 3 POLE	2	EA	A2XF1-XF6
424 0602 000	GROMMET 1-1/4 MTG DIA	2	EA	
424 0616 000	BELT, HTD TIMING 1050MM	1	EA	
430 0217 000	FAN BLADE,16" 20DEG PITCH	2	EA	
436 0294 000	MOTOR 1/2 HP 50/60 HZ 3PH	2	EA	A2B1 A2B2
438 0158 000	PULLEY, HTD TIMING 34G	3	EA	
438 0159 000	PULLEY, HTD TIMING 20G	1	EA	
448 0957 000	HINGE DOOR POSITIONING	3	EA	
448 0958 000	FILTER, AIR	4	EA	
448 0959 000	FILTER, AIR	2	EA	
450 0026 000	BEARING, FLANGE TYPE	10	EA	#C001
456 0144 000	SPRING, EJECTOR	4	EA	
492 0743 000	COIL, AIR-WOUND 125UH	1	EA	L003
504 0398 000	CAP 270PF 30KV 5%	1	EA	C004F
504 0459 000	CAP 330PF 30KV 5%	1	EA	C003B
512 0056 000	CAP, 500PF 15KV	3	EA	C002D,C002N,C004E
512 0325 000	CAP 1000PF 15KV TEST	3	EA	C002M,C004A,C004D
512 0350 000	CAP VAC 2000PF 15KV	10	EA	C002A,C002B,C002E,C002F,C002G,C002H,C002J,C002K,C002L,C004C
512 0360 000	* CAP 2000PF 35KV TEST	1	EA	C001A
514 0339 000	CAP. VAR-12-500PF 15KV	1	EA	C003A
514 0341 000	CAP, VAR 2000PF 35KV	3	EA	C001B,C001C,C001D

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516 0208 000	CAP, RF, 50PF 15KV 10% NPO	1	EA	C005
530 0002 000	FLANGE, MOUNTING, VACUUM CAP	8	EA	#C002D,#C002N,#C004B,#C004E
530 0005 000	FLG MTG TERMINAL FM2	1	EA	#C003A
530 0008 000	FLANGE MOUNT FM2S	1	EA	#C003A
580 0009 000	RELAY, VACUUM, SPST	11	EA	K002EF,K002L,K002M,K002N,K003B,K004C,K004D,K004E,K004F,K200GH ,K200JK
580 0010 000	RELAY, VAC SPDT 26.5VDC	1	EA	K005
604 1079 000	SW DPST 15A 125/250 VAC	4	EA	S001,S002,S003,S007
646 1253 201	LABEL, WARNING	2		
817 2150 037	GROUNDING PLATE	1		
817 2150 044	FLOW MONITOR ANGLE	1		
817 2150 050	OUTPUT ROD	1		#J002
822 0981 047	GND ROD HANDLE	2		
822 0999 087	HINGE PLATE	3		
917 2150 063	STRAP, CAPACITOR	1	EA	OUTPUT SAMPLE STRAP
917 2150 509	SHAFT BEARING BLOCK	2	EA	#A008,#A009
917 2150 512	STANDOFF	2	EA	#C001
917 2150 513	RELAY STANDOFF	10	EA	
917 2150 514	CAP STANDOFF	16	EA	#C002D,#C002N,#C004B,#C004E
917 2150 515	CAP STANDOFF	4	EA	#C004
917 2150 518	BEARING BLOCK SPACER	5	EA	
917 2150 519	CAP COUPLING SHAFT	3	EA	#C001
917 2150 520	CAP DRV/DLER	1	EA	#C001
917 2150 523	COIL SUPPORT ROD	1	EA	#L001
917 2150 525	CAP DRV SHAFT	4	EA	#C001
917 2150 526	CAP MAIN DRV SHAFT	1	EA	
917 2150 531	STANDOFF	6	EA	#C001
917 2150 532	GND HOOK	2	EA	
917 2150 534	COUPLING	1	EA	
917 2150 537	WASHER	1	EA	
917 2150 538	WASHER	2	EA	
917 2150 553	CAP TOP COND ROD	1	EA	
917 2150 583	COUPLING	2	EA	
917 2150 584	COUPLING	2	EA	
917 2150 591	SHAFT COUPLING	5	EA	
917 2150 597	STANDOFF	1	EA	
917 2150 598	STANDOFF	2	EA	
917 2150 601	STANDOFF	4	EA	#C004
917 2150 716	STRAP	1	EA	L3-J2
917 2150 717	STRAP	2	EA	K5COM-C5 K5NO-RF
922 0922 091	SWITCH MTG ANGLE	1	EA	#S001
922 0999 516	INNER CONDUCTOR 4-1/2"	1	EA	#J002
922 0999 517	INSULATOR	1	EA	#J002
922 0999 518	WASHER	1	EA	#J002
922 0999 536	COUPLING 3/8 TO 1/2	2	EA	
922 0999 537	IND DRIVE SHAFT	1	EA	#L002
922 0999 538	CAP DRIVE SHAFT	1	EA	#C001
922 0999 540	RT ANG DRIVE PLATE	1	EA	#C001
922 0999 543	COIL MTG PLT	2	EA	#L003
922 0999 546	SWITCH SUPPORT ANGLE	2	EA	
922 0999 547	BEARING BLOCK	10	EA	#C001
922 0999 548	CAP PLT MTG ANGLE	2	EA	#C001
922 0999 549	IND SHELF MTG ANGLE	1	EA	
922 0999 550	IND SHELF MTG ANGLE	1	EA	
922 0999 552	STANDOFF	4	EA	#L002

WARNING: Disconnect primary power prior to servicing.

922 0999 553	STANDOFF	2	EA	#L002
922 0999 556	COND ASSY	1	EA	
922 0999 557	GND HOOK MTG ANGLE	2	EA	
922 0999 558	SWITCH MTG ANGLE	2	EA	
922 0999 559	SPARK GAP BAR 4-1/2	1	EA	#J002
922 0999 562	SHIPPING PLATE	1	EA	#J002
922 0999 577	SUPPORT BAR MTG ANGLE	2	EA	
922 0999 594	STANDOFF	4	EA	
922 0999 595	STANDOFF	3	EA	#L003
922 0999 596	CAP MTG PLATE	4	EA	#C002D,#C002N,#C004B,#C004E
922 0999 626	STRAP	4	EA	C2J - C2K C2A - C2B C2E - C2F C2G - C2H
922 0999 627	STRAP	1	EA	C2B - L2-2
922 0999 628	STRAP	18	EA	C004A,C004B (2) K2JK - C2K (2) K2N - C2N (2) K2M - C2M (2) C2A - C2D (2) C2A - K2GH (2) K2L - C2L (2) K2GH - C2G (2) K2EF - C2E
922 0999 629	STRAP	2	EA	(2) K2EF - C2D
922 0999 630	STRAP	8	EA	(2) K2JK - COND (2) K2N - COND (2) K2M - COND (2) K2L - COND
922 0999 631	STRAP	2	EA	(2) COND - C2A
922 0999 632	STRAP	1	EA	COND - C2A
922 0999 633	STRAP	2	EA	(2) K4E - C4E
922 0999 634	STRAP	2	EA	(2) K4F - C4F
922 0999 635	STRAP	2	EA	(2) K4D - C4D
922 0999 636	STRAP	2	EA	(2) K4C - C4C
922 0999 637	STRAP	2	EA	(2) K3B - C3A
922 0999 638	STRAP	2	EA	(2) K3B - C3B
922 0999 639	STRAP	2	EA	L2 - L2
922 0999 640	STRAP	2	EA	(2) K3B - K4F
922 0999 736	SWITCH MTG ANGLE	1	EA	#S007
922 0999 738	TUBE STRAP	1	EA	C3A - L2 FRT
922 0999 742	TUBE STRAP	1	EA	C4A - C3A
922 0999 743	TUBE STRAP	1	EA	C3B - C3A
922 0999 746	TUBE STRAP	1	EA	L2 FRT - L2 ROTOR
927 1701 001	YOKE COUPLING ASSY	1	EA	
927 1701 002	YOKE COUPLING ASSY	9	EA	
939 7930 566	PSC/ONC FAN ACCESS PLT	1	EA	
939 7930 569	FLANGE 4-1/2"	1	EA	#J002
939 7930 576	ONC REAR ACCESS PNL	1	EA	
939 7930 582	CAP SHELF ANGLE	1	EA	
939 7930 583	CAP MTG PLATE	2	EA	#C003A
939 7930 584	SAMPLE BD MTG ANGLE	2	EA	
939 7930 590	COND. STRAP	1	EA	
939 7930 591	COND. SUPPORT BAR	1	EA	
939 7930 593	INDUCTOR LEAD	1	EA	#L001
939 7930 602	DRIVE PNL DOUBLER PLT	1	EA	
939 7930 604	CAP MTG PLATE	1	EA	#C003B
939 7930 655	INDUCTOR	1	EA	L001
939 7930 656	LT COIL MTG CHNL	1	EA	#L001
939 7930 657	RT COIL MTG CHNL	1	EA	#L001
939 7930 658	BTM COIL MTG CHNL	1	EA	#L001
939 7930 659	RELAY MTG BRKT	1	EA	
939 7930 661	CAP MTG BRKT	1	EA	
943 5155 560	COIL ASSY	1	EA	L002
943 5155 564	PSC/ONC DOOR COVER ASSY	1	EA	
943 5155 565	PSC/ONC REAR DOOR	1	EA	
943 5155 579	ONC ASSEMBLY	1	EA	
943 5155 583	ONC BASE SHIELD	1	EA	

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943 5155 584	ONC TOP	1	EA	
943 5155 585	CAP MTG CHANNEL	2	EA	#C001
943 5155 586	CAP MTG PLATE	1	EA	#C001
943 5155 587	CAP BTM CONTACT PLT	1	EA	#C001
943 5155 588	ONC LT INNER PNL	1	EA	
943 5155 589	ONC RT INNER PNL	1	EA	
943 5155 590	CAP SHELF	1	EA	
943 5155 591	RELAY MTG ANGLE	1	EA	
943 5155 592	RELAY HOUSING	1	EA	
943 5155 593	IND SHELF	1	EA	
943 5155 594	CAP SHELF	1	EA	
943 5155 595	FRONT PANEL	1	EA	
943 5155 596	DRIVE COVER	1	EA	
943 5155 807	TUBE STRAP	1	EA	L2 FRT - J2
943 5155 811	OUTPUT MONITOR COAX	1	EA	
943 5155 812	RIBBON CABLES, ONC	1	EA	
952 9180 009	CABLE ONC 100KW FA	1	EA	
992 8203 001	PWA, OUTPUT SAMPLE, ESD SAFE	1	EA	A001
992 8363 001	AIR FLOW MONITOR	1	EA	A003
992 8552 001	INDUCTOR SERVO DRIVE	1	EA	A007
992 8555 001	MOTORIZED SWITCH	2	EA	A008,A009
992 8677 001	PWA, ARC DETECTOR	2	EA	A004,A005

Table 7-28. RIBBON CABLES, ONC - 943 5155 812 (B1)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
2500341000A	*CABLE, RIBBON 20 COND 28 AWG	6.100	FT	
250 0454 000	CABLE, FLAT 5 PAIRS 28AWG	3.300	FT	
612 0995 000	RECP 10C 2 ROW STRAIGHT IDC	4	EA	
612 0996 000	RECP 20C 2 ROW STRAIGHT IDC	3	EA	
646 1324 000	MARKER, CABLE .8 X 1.437"	4		
646 1325 000	MARKER, CABLE 1.9" X 3.19	3		
843 5155 812	CABLES, RIBBON, ONC	0		

Table 7-29. CABLE ONC 100KW FA - 952 9180 009 (S3)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
250 0212 000	CABLE, 6 PR 12C 22AWG	17	FT	
250 0305 000	CABLE 2C 16AWG TWISTED PR	31.900	FT	
250 0366 000	CABLE, 10C 24AWG 5 PR	2.500	FT	
2520002000A	*WIRE, STRD 22AWG GRN	0.200	FT	
2520006000A	*WIRE, STRD 14AWG BLU	105.600	FT	
253 0031 000	WIRE, 2C 20AWG STRD	30.700	FT	
253 0074 000	CABLE 4C 22AWG 400V	6.200	FT	
2540017000A	*WIRE, ROPE 10AWG	3.500	FT	
296 0019 000	PLASTIC TUBE 4AWG CLEAR	3.500	FT	
296 0253 000	TUBING, SHRINK 3/16 WHITE	0.160	FT	
296 0261 000	TUBING, SHRINK 1/8 WHITE	1	FT	
296 0262 000	TUBING, SHRINK 1/4 WHITE	3.300	FT	
296 0263 000	TUBING, SHRINK 3/8 WHITE	0.200	FT	
296 0264 000	TUBING, SHRINK 1/2 WHITE	1.400	FT	
296 0265 000	TUBING, SHRINK 1/16 WHITE	2.200	FT	
296 0271 000	TUBING, SHRINK 3/4 WHITE	0.080	FT	
354 0001 000	LUG #6 RING RED 22-18 AWG	11	EA	

WARNING: Disconnect primary power prior to servicing.

354 0008 000	LUG #6 RING BLUE 16-14AWG	1	EA
354 0009 000	LUG #8 RING BLUE 16-14AWG	1	EA
354 0010 000	LUG #10 RING BLU 16-14AWG	1	EA
354 0015 000	LUG BLUE SPADE 6	11	EA
354 0023 000	LUG #6 RING YEL 12-10AWG	3	EA
354 0252 000	TERM 250 FEM BLU 16-14	28	EA
354 0287 000	LUG #10 RING N/INS 7-9AWG	1	EA
354 0289 000	LUG .25 RING N/INS 7-9AWG	1	EA
354 0697 000	CONTACT, SOCKET	8	EA
354 0796 000	CONTACT, PIN 20-14 AWG	24	EA
354 0797 000	CONTACT, SOCKET 20-14 AWG	8	EA
358 2995 000	END PLATE, 261 TERM BD	2	EA
358 3358 000	D CONN SHIELD METAL CAST	2	EA
358 3360 000	JACKSCREW 2.7L	4	EA
358 3366 000	D CONN SHIELD PLATED	1	EA
358 3367 000	D CONN SHIELD PLATED	1	EA
358 3378 000	BACKSHELL METAL CAST 15PD	3	EA
358 3380 000	D CONN EMI BACKSHELL	1	EA
610 0843 000	HOUSING 12 PIN CONN PLUG	1	EA
610 1104 000	HOUSING 4 PIN CONN CAP	1	EA
610 1129 000	D CONN 9P PLUG	1	EA
610 1144 000	HOUSING 12 PIN CONN CAP	1	EA
612 1326 000	HOUSING, 4 PIN CONN PLUG	4	EA
612 1384 000	D CONN 15P RECEPTACLE	3	EA
612 1387 000	RECEPTACLE 9P D IDC	4	EA
614 0786 000	TERM BD, 2C MODULAR 261	22	EA
618 0705 000	COAX CABLE,RG316/U 50 OHM	3	FT
620 0566 000	PLUG, RT ANGLE UG1466/U SMC	2	EA
817 2150 536	CADS, ONC CABLE	0	
852 9180 501	CABLE LAYOUT (*), ONC RIZ	0	

Table 7-30. PWA, OUTPUT SAMPLE, ESD SAFE - 992 8203 001 (M)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
358 1928 000	JUMPER 1/4 LG 1/8H	1	EA	JP004
358 3092 000	STUD, BRS 6-32 X 3/8	3	EA	#C012,#C013,#C014
494 0394 000	CHOKE 6.80UH	2	EA	L001,L002
500 0843 000	CAP, MICA, 910PF 100V 5%	2	EA	C015,C016
500 0878 000	CAP, MICA, 1500PF 500V 5%	2	EA	C008,C017
516 0202 000	CAP, RF, 50PF 7.5KV 10% NPO	1	EA	C007
516 0413 000	CAP, RF, 10PF 7.5KV 10% NPO	6	EA	C009,C010,C011,C012,C013,C014
546 0318 000	RES 56 OHM 5W 5%	8	EA	R010,R011,R012,R013,R014,R015,R016,R017
546 0319 000	RES 30 OHM 5W 5%	4	EA	R001,R002,R003,R004
548 2400 166	RES 47.5 OHM 1/2W 1%	2	EA	R018,R019
610 0679 000	PLUG, SHORTING, .25" CTRS	2	EA	P001,P002
610 0980 000	*HDR 20C RT ANG 2ROW TOP LATCH	1	EA	J001
612 1012 000	JACK PC MT .040 PINS	6	EA	3#P001 3#P002
620 0515 000	RECP, SCREW ON SMC	1	EA	J004
620 1677 000	RECEPTACLE, PC MT, BNC	1	EA	J002
817 2150 049	CAP PLATE	1		#C012,#C013,#C014
839 7930 018	SCHEMATIC, OUTPUT SAMPLE	0		
843 5155 018	PWB, OUTPUT SAMPLE	1		
922 0922 025	TRANSFORMER	2	EA	T001,T002
999 2631 001	HARDWARE LIST	1	EA	

WARNING: Disconnect primary power prior to servicing.

Table 7-31. CAPACITOR SERVO DRIVE - 992 8551 001 (H)

Harris PN	Description	QTY	UM	Reference Designators
306 0052 000	NUT, STOP 3/8-16	1	EA	
336 0264 000	PIN SPRING	1	EA	
354 0147 000	LUG, SHAKE #6 45 DEG	1	EA	E002
356 0087 000	CABLE TIE TY RAP	2	EA	
358 2995 000	END PLATE, 261 TERM BD	1	EA	#TB001
424 0149 000	BELT NO-SLIP 126 T	1	EA	
424 0623 000	BELT 710MM 60 DEG V-FLEX	1	EA	
438 0054 000	PULLEY, NO-SLIP	1	EA	
450 0055 000	BEARING, BALL FS3KDD	1	EA	
450 0056 000	BEARING, BALL FS1KDD7	1	EA	
450 0173 000	BEARING, THRUST 3/8 ID	2	EA	
548 0402 000	RES .5 OHM 10W 1%	2	EA	R004,R005
548 2400 218	RES 150 OHM 1/2W 1%	1	EA	R003
552 0827 000	POT 10K 2W 5%	1	EA	R001
614 0127 000	TERM STRIP 1 TERM	1	EA	E003
614 0786 000	TERM BD, 2C MODULAR 261	1	EA	#TB001
614 0787 000	TERM BD, 4C MODULAR 261	5	EA	#TB001
839 7930 717	SCHEM, SERVO DRIVE ASSY	0		
917 2150 600	MOTOR ASSY - DRIVE UNITS	1	EA	B001
922 0999 527	POT ADJUST PLT	1	EA	
922 0999 528	POT ASSY ADJUST PLT	1	EA	
922 0999 530	MOTOR MTG PLT	1	EA	
922 0999 619	CAP SRV SHAFT ASSY	1	EA	
922 0999 676	SERVO STOP BLOCK	1	EA	
939 7930 575	SERVO END PLT	1	EA	
939 7930 768	SERVO ASSY CABLE	1	EA	
943 5155 582	SERVO BASE PLT	1	EA	

Table 7-32. INDUCTOR SERVO DRIVE - 992 8552 001 (G)

Harris PN	Description	QTY	UM	Reference Designators
306 0052 000	NUT, STOP 3/8-16	1	EA	
336 0264 000	PIN SPRING	1	EA	
354 0147 000	LUG, SHAKE #6 45 DEG	1	EA	E002
356 0087 000	CABLE TIE TY RAP	2	EA	
358 0412 000	RING RETAINING .375	1	EA	
358 2995 000	END PLATE, 261 TERM BD	1	EA	#TB001
424 0149 000	BELT NO-SLIP 126 T	1	EA	
424 0615 000	BELT, HTD TIMING 600MM	1	EA	
424 0623 000	BELT 710MM 60 DEG V-FLEX	1	EA	
438 0054 000	PULLEY, NO-SLIP	1	EA	
450 0055 000	BEARING, BALL FS3KDD	3	EA	
450 0056 000	BEARING, BALL FS1KDD7	1	EA	
450 0173 000	BEARING, THRUST 3/8 ID	2	EA	
548 0402 000	RES .5 OHM 10W 1%	2	EA	R004,R005
548 2400 218	RES 150 OHM 1/2W 1%	1	EA	R003
552 0827 000	POT 10K 2W 5%	1	EA	R001
614 0127 000	TERM STRIP 1 TERM	1	EA	E003
614 0786 000	TERM BD, 2C MODULAR 261	1	EA	#TB001
614 0787 000	TERM BD, 4C MODULAR 261	5	EA	#TB001
839 7930 717	SCHEM, SERVO DRIVE ASSY	0		
917 2150 600	MOTOR ASSY - DRIVE UNITS	1	EA	B001

WARNING: Disconnect primary power prior to servicing.

922 0999 527	POT ADJUST PLT	1	EA
922 0999 528	POT ASSY ADJUST PLT	1	EA
922 0999 529	PULLEY RETAINING CVR	1	EA
922 0999 530	MOTOR MTG PLT	1	EA
922 0999 534	IDLER PULLEY	1	EA
922 0999 535	IDLER SHAFT	1	EA
922 0999 614	COIL SERVO SHAFT ASSY	1	EA
922 0999 615	INDUCTOR SRV SHAFT ASSY	1	EA
922 0999 676	SERVO STOP BLOCK	1	EA
939 7930 575	SERVO END PLT	1	EA
939 7930 768	SERVO ASSY CABLE	1	EA
943 5155 582	SERVO BASE PLT	1	EA

Table 7-33. MOTORIZED SWITCH - 992 8555 001 (H)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
336 1135 000	PIN, SPRING	2	EA	
336 1137 000	PIN, SPRING	1	EA	
358 1214 000	SCREWLOCK, FEMALE	4	EA	
384 0020 000	RECTIFIER IN4005 ESD	1	EA	CR001
404 0200 000	RELAY SOCKET	1	EA	XK001
450 0127 000	CAM YOKE FOLLOWER	1	EA	
542 0170 000	RES 50 OHM 5% 25W	1	EA	R001
572 0127 000	RELAY 4PDT 24VDC	1	EA	K001
604 0624 001	SW, SIMLTD ROLLER, SPDT, 11A	4	EA	S001,S002,S003,S004
610 1129 000	D CONN 9P PLUG	2	EA	
829 0213 001	CONTACT SPRING	1		
839 7930 716	SCHEM, MOTORIZED SWITCH	0		
916 7727 001	MOTOR MODIFICATION	1	EA	B001
917 2150 507	SW ROD MTG BLOCK	1	EA	
917 2150 508	SWITCH TRIP ROD	1	EA	
917 2150 509	SHAFT BEARING BLOCK	1	EA	
917 2150 510	SW CONTACT BLOCK	1	EA	
917 2150 511	SW PIVOT BLOCK	1	EA	
917 2150 516	SWITCH PIVOT NUT	1	EA	
917 2150 517	SHAFT COUPLING	1	EA	
917 2150 521	SWITCH CAM ARM	1	EA	
917 2150 522	SWITCH CAM PLATE	1	EA	
922 0999 539	IND SWITCH SHAFT	1	EA	
922 0999 544	MICROSWITCH SHIELD	2	EA	
922 0999 545	SW CAM PLATE GUIDE	2	EA	
939 7930 577	SWITCH BASE	1	EA	
939 7930 578	SWITCH TOP	1	EA	
939 7930 579	SWITCH SW ANGLE	1	EA	
939 7930 580	SWITCH MOTOR ANGLE	1	EA	
939 7930 581	SWITCH COVER	1	EA	
939 7930 769	MOTOR SWITCH CABLE	2	EA	

Table 7-34. PWA, ARC DETECTOR - 992 8677 001 (E)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
335 0244 000	WASHER, SHLDR 5/16 SCREW	2	EA	XR001,XR002
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP001,JP002
516 0453 000	CAP .1UF 100V 20% X7R	4	EA	C001,C002,C003,C004

WARNING: Disconnect primary power prior to servicing.

548 2400 142	RES 26.7 OHM 1/2W 1%	2	EA	R003,R004
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	1	EA	J001
670 0049 000	PHOTOCELL TO-8 HERMETIC	2		R001,R002
839 7930 517	SCHEM, ARC DETECTOR BD	0		
843 5155 517	PWB, ARC DETECTOR	1		

Table 7-35. POWER SUPPLY CABINET - 992 8520 002 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
328 0070 000	WASHER CUPPED BLACK WEAR	16	EA	
328 0071 000	WASHER, STEEL COMPRESSION	4	EA	#Q001,Q002,Q003,Q004
328 0073 000	WASHER, RETAINER	16	EA	
335 0252 000	WASHER, TEFLON	8	EA	#CR25 - ALL ODD TO #CR37#CR38
354 0624 000	TERMINAL, MALE	4	EA	#A1J1
354 0625 000	TERMINAL, FEMALE	4	EA	#P005
354 0760 000	TAB ADAPTOR 250 SERIES	3	EA	
358 0003 000	BRACKET RESISTOR MTG	9	EA	#R025,#R026,#R027,#R028,#R034,#R035,#R037
358 0300 000	PLUG BUTTON .625 HOLE	1	EA	#CB005
358 2628 000	CABLE PUSH MOUNT	8	EA	
358 2995 000	END PLATE, 261 TERM BD	4	EA	#TB007,#TB009,#TB010,#TB011
358 2998 000	PLATE, END COVER (281, 3-COND)	13	EA	13#TB8
358 3000 000	PLATE, END STOP, DIN RAIL MT	2	EA	2#TB8
358 3122 000	STUD, BRS 10-32 X 1-1/4	19	EA	
358 3246 000	STUD 1/4 TURN PHILLIPS HD	10	EA	
380 0722 000	XSTR IRFP360 ESD	4	EA	Q001,Q002,Q003,Q004
384 0695 000	LED GREEN CART 12V ESD	6	EA	DS006,DS007,DS008,DS009,DS010,DS012
384 0702 000	RECT FW BRIDGE 600V 35A ESD	5	EA	CR043,CR045,CR046,CR048,CR049
384 0705 000	RECT 85A 1000V PIV ESD	15	EA	CR025,CR026,CR027,CR028,CR029,CR030,CR031,CR032,CR033,CR034 ,CR035,CR036,CR037,CR038,CR047
384 0761 000	BRIDGE, FW 100A 200V ESD	1	EA	CR044
384 0839 000	RECT 1000PIV 275A 1N4056 ESD	24	EA	CR1A,CR1B,CR23A,CR23B - ALL ODD TO - ALL ODD TO
384 0840 000	RECT 1000PIV 275A 1N4056R ESD	24	EA	CR2A -ALL EVEN TO -CR24ACR2B -ALL EVEN TO -CR24B
384 0939 000	RECT FW BRIDGE 1KV 35A ESD	1	EA	CR050
386 0085 000	ZENER, 1N4740A 10V ESD	4	EA	CR039,CR040,CR041,CR042
396 0250 000	LAMP, NEON GRN INDICATOR	5	EA	DS001,DS002,DS003,DS004,DS005
398 0431 000	FUSE 1 TIME 3A 250VAC	1	EA	F014
398 0432 000	FUSE 1 TIME 10A 250VAC	3	EA	F015 A1F16 A2F16
398 0455 000	FUSE, TIME-DELAY, 15 AMP 500V	8	EA	F001,F002,F003,F004,F005,F011,F012,F013
398 0456 000	FUSE, TIME-DELAY, 1 AMP 500V	3	EA	F006,F007,F008
398 0457 000	FUSE, SEMICONDUCTOR, 250A	24	EA	A1F1 A1F2 A1F3 A1F4 A1F5 A1F6 A1F7 A1F8 A1F9 A1F10 A1F11 A1F12 A2F1 A2F2 A2F3 A2F4 A2F5 A2F6 A2F7 A2F8 A2F9 A2F10 A2F11 A2F12
398 0463 000	FUSE 40A 250V	6	EA	A1F13-A1F15 A2F13-A2F15
398 0471 000	FUSE, TIME-DELAY, 1.5 AMP 500V	6	EA	F001,F002,F003,F004,F005,F006
402 0014 000	FUSE HOLDER, 2 POLE	3	EA	XF14-15 A1XF16-17 A2XF16-17
402 0087 000	FUSE HOLDER, 60A 250V	2	EA	A1XF13-15 A2XF13-15
402 0130 000	FUSE HOLDER, 3 POLE	5	EA	XF3-5,XF6-8,XF11-13 A3XF1-3 A3XF4-6
402 0177 000	FUSE BLOCK, 2 POLE, 600V	1	EA	XF1-2
410 0413 000	THERMAL INTERFACE, TO-247	8	EA	#Q001,#Q002,#Q003,#Q004
424 0602 000	GROMMET 1-1/4 MTG DIA	10	EA	
430 0217 000	FAN BLADE,16" 20DEG PITCH	2	EA	
436 0294 000	MOTOR 1/2 HP 50/60 HZ 3PH	2	EA	
448 0224 000	HANDLE ALUM	2	EA	
448 0957 000	HINGE DOOR POSITIONING	3	EA	#A001
448 0958 000	FILTER, AIR	4	EA	

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448 0959 000	FILTER, AIR	2	EA	
456 0144 000	SPRING, EJECTOR	16	EA	
472 1660 000	XFMR, PWR	2	EA	A1T1 A2T1
472 1666 000	XFMR, INTERPHASE	2	EA	A1T2 A2T2
472 1685 000	XFMR, PWR 817-2150-006	1	EA	T006
472 1686 000	XFMR, PWR, 817-2150-008	1	EA	T005
472 1700 000	XFMR, PWR, CT	1	EA	T007
476 0416 000	CHOKE, FLTR 10MHY 12.5ADC	3	EA	L001,L002,L003
506 0090 000	* CAP .47UF 600V 10%	1	EA	C017
508 0537 000	CAP .047 UF 600WVDC 5%	1	EA	C015
508 0539 000	CAP 2 UF 400VDC 10%	4	EA	C001,C002,C003,C004
508 0554 000	CAP 3300PF 600WVDC	2	EA	C021,C022
516 0411 000	CAP .1UF 50V DISC	1	EA	C016
524 0181 000	CAP 2700UF 25V	1	EA	C007
524 0313 000	CAP 25,000UF 40VDC -10, +75%	5	EA	C008,C009,C012,C013,C014
524 0322 000	CAP 15000UF 100WVDC -10, +75%	2	EA	C005,C006
524 0342 000	CAP 76000UF 40WVDC -10, +75%	3	EA	C018,C019,C020
524 0380 000	CAP 120,000UF 50WVDC -10, +75%	3	EA	C010,C011,C210
530 0094 000	BRACKET, CAP, 1.375"ID	1	EA	#C007
540 1600 015	RES 3.9 OHM 3W 5%	2	EA	R044,R045
540 1600 101	RES 10 OHM 3W 5%	1	EA	R022
540 1600 118	RES 51 OHM 3W 5%	1	EA	R036
540 1600 208	RES 200 OHM 3W 5%	3	EA	R010,R011,R210
540 1600 213	RES 330 OHM 3W 5%	4	EA	R029,R030,R031,R032
540 1600 215	RES 390 OHM 3W 5%	2	EA	R042,R043
540 1600 218	RES 510 OHM 3W 5%	10	EA	R006,R007,R008,R009,R012,R013,R038,R039,R040,R041
540 1600 301	RES 1K OHM 3W 5%	2	EA	R020,R021
540 1600 408	RES 20K OHM 3W 5%	3	EA	R015,R017,R019
540 1600 410	RES 24K OHM 3W 5%	2	EA	R023,R024
540 1600 415	RES 39K OHM 3W 5%	3	EA	R014,R016,R018
540 1600 419	RES 56K OHM 3W 5%	2	EA	R004,R005
542 0095 000	RES 10K OHM 5% 12W	1	EA	R033
542 0287 000	RES 10 OHM 5% 100W	5	EA	R025,R026,R027,R028,R037
542 0293 000	RES 250 OHM 5% 100W	2	EA	R034,R035
542 1729 000	RES 2.8 OHM 744W 10%	3	EA	R001,R002,R003
560 0049 000	MOV, 275WVAC, 75J, 14MM DISC	2	EA	RV013,RV014
560 0077 000	MOV, 275WVAC, 400J, 40MM DISC	12	EA	RV001,RV002,RV003,RV004,RV005,RV006,RV007,RV008,RV009,RV010,RV011,RV012
570 0355 000	CONTACTOR, 400A 3 PHASE	1	EA	K002
570 0372 000	CONTACTOR 90A 3 POLE 50HZ	1	EA	K001
574 0436 000	RELAY, SS, AC, 10A, SPST	3	EA	K003,K004,K005
584 0306 000	*AUXILIARY CONTACT SET 1 N.O.	1	EA	#K001
584 0343 000	AUXILIARY CONTACT SET N.C.	1	EA	#K001
604 1079 000	SW DPST 15A 125/250 VAC	5	EA	S003,S005,S006,S007,S008
606 0480 000	BREAKER, CKT 5A.	1	EA	CB003
606 0828 000	CB, 1 POLE, 0.5 AMP 250VAC.	1	EA	CB002
606 0830 000	CKT BREAKER 2 POLE	1	EA	CB006
606 0853 000	CKT BREAKER 2 POLE 7A	1	EA	CB001
606 0873 000	CKT BREAKER 2 POLE	1	EA	CB004
614 0052 000	TERM BD 8 TERM	4	EA	TB001,TB005,TB006,TB013
614 0056 000	TERM BD 12 TERM	1	EA	TB003
614 0438 000	TERM, STANDOFF	1	EA	
614 0774 000	*INTERFACE, 40 PIN, TB/HDR	1	EA	TB004
614 0786 000	TERM BD, 2C MODULAR 261	9	EA	1#TB11 2#TB10 2#TB9 4#TB7
614 0787 000	TERM BD, 4C MODULAR 261	5	EA	4#TB11 1#TB7

WARNING: Disconnect primary power prior to servicing.

614 0793 000	TERM BLOCK,3C MODULAR 281	12	EA	12#TB8
614 0817 000	JUMPER, TERM BLK, 20 POS	1	EA	#TB004
646 0973 000	*LABEL, 230V	4		
646 1253 201	LABEL, WARNING	4		
646 1350 000	MARKER STRIP 12 TERM	1		TB003
646 1386 000	STRIP, MKR 8 TERM	4		#TB001,#TB005,#TB006,#TB013
740 1183 000	MONITOR, CURRENT	4	EA	K006,K007,K008,K009
740 1185 000	MONITOR, PHASE/VOLTAGE	1	EA	K010
813 4999 034	STDOFF 6-32X2.00 1/4 HEX	4		
813 5007 026	STDOFF 6-32X1/2 1/4 DIA	4		#A2
817 2150 023	BUS BAR INSULATOR	1		
817 2150 037	GROUNDING PLATE	3		
822 0922 040	STDOFF, 1 X 2 X 5/16	28		
822 0922 048	SWITCH PLUNGER	1		
822 0999 010	STDOFF 1.0 X 4.0 X 5/16	12		
822 0999 018	PAC/PSC DISPLAY TRIM	2		
822 0999 049	POS BUS BAR ANGLE	1		
822 0999 050	NEG BUS BAR	1		
822 0999 051	NEG BUS BAR TERM	1		
822 0999 053	MTG TERM BOARD	1		
822 0999 055	PSC RECTIFIER HS	2		
822 0999 060	PSC CABLE CLAMP	2		
822 0999 064	STDOFF 1.0 X 1.25 X 10-32	3		
822 0999 076	BUS BAR	2		
822 0999 086	TERM BLOCK COVER	3		
822 0999 087	HINGE PLATE	3		
822 0999 094	PSC SHORTING SWITCH CVR	1		
822 0999 095	CROWBAR SHIELD	1		
822 0999 122	STRAP	1		
829 9009 187	MOUNTING PLATE TERM BLOCK	1		
839 7930 114	XFMR PLATE	2		
839 7930 133	RELAY COVER	1		#K005
839 7930 134	DISPLAY PANEL COVER	1		
843 5155 552	SCHEM, POWER SUPPLY	0		
917 2150 029	TEMP SENSOR	4	EA	U001,U002,U003,U004
917 2150 535	STANDOFF	8	EA	
917 2150 544	STANDOFF	8	EA	#T006
917 2150 545	STANDOFF	8	EA	
917 2150 548	STOP WASHER	6	EA	#R001,#R002,#R003
917 2150 554	STANDOFF	6	EA	#R001,#R002,#R003
917 2150 610	PWR SUPPLY CABLE PKG	1	EA	
917 2244 001	SPACER, 1.0 LG .75 DIA	4	EA	
917 2332 049	INSULATOR, 3/8 D. X 1 LG.	2	EA	#R044,#R045
922 0999 054	PSC DISPLAY PNL ANGLE	2	EA	
922 0999 059	PSC REAR ACCESS ANGLE	3	EA	
922 0999 068	SWITCH HOT PLATE ASSY	1	EA	
922 0999 070	SW SPRING CONTACT ASSY	1	EA	
922 0999 091	CROWBAR PLATE	1	EA	
922 0999 584	PSC CAP BRACKET	2	EA	
922 0999 599	XFMR SUPPORT ANGLE	4	EA	
922 0999 600	XFMR SUPPORT CHNL	2	EA	
922 0999 736	SWITCH MTG ANGLE	4	EA	#S005,#S006,#S007,#S008
939 7930 104	FRT PNL MTG ANGLE	1	EA	
939 7930 120	REAR BASE ANGLE	1	EA	
939 7930 566	PSC/ONC FAN ACCESS PLT	1	EA	

WARNING: Disconnect primary power prior to servicing.

939 7930 592	PAC CAP BRACKET	2	EA	
939 7930 594	RECTIFIER HEATSINK	8	EA	
939 7930 595	RECTIFIER BUS BAR	4	EA	
939 7930 596	PSC CAP BRACKET	1	EA	
939 7930 597	CLOSEOUT PLATE, REAR	1	EA	
939 7930 598	CLOSEOUT PLATE, REAR	1	EA	
939 7930 599	REAR ACCESS PANEL	1	EA	
939 7930 600	REAR ACCESS PANEL	1	EA	
939 7930 640	CABLE SUPPORT BAR	1	EA	
943 5155 137	PSC DIVIDER PNL	1	EA	
943 5155 146	REAR SIDE ANGLE	2	EA	
943 5155 564	PSC/ONC DOOR COVER ASSY	1	EA	
943 5155 565	PSC/ONC REAR DOOR	1	EA	
943 5155 620	POWER SUPPLY CABINET	1	EA	
943 5155 621	PSC SHELF ANGLE	1	EA	
943 5155 622	PSC RT OUTER PNL	1	EA	
943 5155 623	PSC SHELF	1	EA	
943 5155 624	PSC LT OUTER PNL	1	EA	
943 5155 625	PSC TOP	1	EA	
943 5155 626	REAR ANGLE	2	EA	
943 5155 629	PSC LT INNER PNL	1	EA	
943 5155 632	PSC DISPLAY PNL	1	EA	
943 5155 633	PSC LOWER FRT PNL	1	EA	
943 5155 634	PSC UPPER FRT PNL	1	EA	
943 5155 827	RIGHT INNER PANEL, PSC	1	EA	
992 8684 002	POWER SUPPLY DISCHARGE	1	EA	A2

Table 7-36. POWER SUPPLY DISCHARGE - 992 8684 002 (H)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
328 0071 000	WASHER, STEEL COMPRESSION	4	EA	#Q001,#Q002,#Q003,#Q004
380 0722 000	XSTR IRFP360 ESD	4	EA	Q001,Q002,Q003,Q004
386 0085 000	ZENER, 1N4740A 10V ESD	4	EA	CR004,CR005,CR008,CR009
410 0413 000	THERMAL INTERFACE, TO-247	4	EA	#Q001,#Q002,#Q003,#Q004
508 0539 000	CAP 2 UF 400VDC 10%	2	EA	C001,C003
516 0864 000	CAP DISC .02UF 1KV +/-20%	4	EA	C008,C009,C013,C014
540 1600 001	RES 1 OHM 3W 5%	2	EA	R001,R003
540 1600 110	RES 24 OHM 3W 5%	4	EA	R008,R009,R013,R014
540 1600 401	RES 10K OHM 3W 5%	4	EA	R006,R007,R011,R012
614 0727 000	TERM BD 8C 1ROW PC MT	2	EA	TB001,TB002
839 7930 518	SCHEM, PWR SUP DISCHARGE	0		
843 5155 518	PWB, PWR SUPPLY DISCHARGE	1		
917 2150 682	DISCHARGE HEATSINK	1	EA	
999 2781 002	HARDWARE LIST, PWR SUP	1	EA	

Table 7-37. UNIQUE PARTS 100-3F - 992 8585 004 (F)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
200000000000001029	BRACKET, SWITCH MTG	1	EA	S100
200000000000001179	CABLE, CONTROL DX100-3F	1	EA	
200000000000001556	SUB ASSY LOCATION PLATE	1	EA	
424 0042 000	GROMMET .381 MTG DIA	1	EA	S100
604 0460 000	SW, TGL DPDT	1	EA	S100
700 1332 000	FREQ SYNTHESIZER MODULE	1		1A1A1

WARNING: Disconnect primary power prior to servicing.

817 2435 974	PROG INSTR,FIRMWARE DX100-3F CONTROLLER	0		1A56 SOFTWARRE
917 2150 564	WINDOW	1	EA	
917 2150 605	PAINTED PLUG BUTTON	4	EA	
922 0999 585	PSC/PAC PLATE	1	EA	
922 0999 623	CLOSEOUT PLATE	1	EA	
943 5155 091	PAC METER/DISPLAY PNL	1	EA	
943 5155 691	VIEW LOCATION PLATE	1	EA	
943 5155 804	CABLE, SHUNT METER	1	EA	
943 5523 981	PANEL, 3 FREQUENCY CONTROL	1.0	EA	
952 9180 505	CABLE, FA100 PWR DIST	1	EA	
952 9180 509	CABLE PAC R-DOOR AC DIST	1	EA	
992 8179 001	RF AMPLIFIER MODULE	3	EA	SPARE PA'S
992 8526 003	FREQ CTRL INTFC BD	1	EA	1A050
992 8537 005	DRIVER ENCODER BD,	1	EA	1A007
992 8540 003	XMTR INTERFACE BD,	1	EA	1A030
992 8588 001	SYNTHESIZER INTERFACE BD	1	EA	1A1
992 8629 001	RF INTERFACE BD,	1	EA	1A003
992 8631 001	EXTERNAL INTERFACE BD,	1	EA	1A023
992 8643 001	POWER SUPPLY INTERFACE	1	EA	1A55
992 9511 588	PWA, DX100-3F CONTROLLER	1	EA	1A56
992 9764 500	PWA, 3 FREQ SELECT	1	EA	1A57

Table 7-38. PAINTED PLUG BUTTON - 917 2150 605 (A)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
817 2150 605	ASSY INSTR, PAINTED PLUG	0		
358 0267 000	NO LONGER AVAILABLE	1	EA	

Table 7-39. PSC/PAC PLATE - 922 0999 585 (A)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
001 5010 020	AL, SH .190 THK	0.334	LB	
822 0999 585	ASSY INSTR, PSC/PAC PLATE	0		

Table 7-40. CLOSEOUT PLATE - 922 0999 623 (A)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
822 0999 623	ASSY INSTR,CLOSEOUT PLATE	0		
001 5010 070	AL, SH .090 THK	0.160	LB	

Table 7-41. PAC METER/DISPLAY PNL - 943 5155 091 (D)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
839 7855 016	SILKSCREEN	0		
839 7930 057	SILKSCREEN, DISPLAY	0		
839 7930 058	SILKSCREEN, SWITCH	0		
843 5155 091	ASSY INSTR, PAC METER/	0		
001 5010 060	AL, SH .063 THK	4.350	LB	
358 3544 003	STANDOFF, PEM 3/8" H SNAP-TOP	7	EA	
358 1551 000	STANDOFF BLIND 6-32 X 1/2	8	EA	
358 2890 000	STANDOFF BLIND 6-32 X 3/8	6	EA	

WARNING: Disconnect primary power prior to servicing.

Table 7-42. VIEW LOCATION PLATE - 943 5155 691 (A)

Harris PN	Description	QTY	UM	Reference Designators
839 7930 643	SILKSCREEN	0		
843 5155 691	ASSY INSTR, VIEW LOCATION	0		
001 5010 030	AL, SH .032 THK	1.407	LB	

Table 7-43. CABLE, SHUNT METER - 943 5155 804 (A)

Harris PN	Description	QTY	UM	Reference Designators
253 0052 000	WIRE, 2C 16AWG SHLD	15.100	FT	
354 0008 000	LUG #6 RING BLUE 16-14AWG	1	EA	
354 0010 000	LUG #10 RING BLU 16-14AWG	4	EA	
817 2150 700	CADS, SHUNT METER CABLE	0		
843 5155 804	CABLE LAYOUT, SHUNT METER	0		

Table 7-44. PANEL, 3 FREQUENCY CONTROL - 943 5523 981 (A)

Harris PN	Description	QTY	UM	Reference Designators
839 7930 780	SILKSCREEN, FREQ CNTL PANEL	0		
843 5523 981	FAB INST, FREQ CNTL PANEL	0		
001 5010 060	AL, SH .063 THK	2.1	LB	
358 1551 000	STANDOFF BLIND 6-32 X 1/2	11.0	EA	
358 2890 000	STANDOFF BLIND 6-32 X 3/8	4.0	EA	

Table 7-45. CABLE, FA100 PWR DIST - 952 9180 505 (J3)

Harris PN	Description	QTY	UM	Reference Designators
250 0212 000	CABLE, 6 PR 12C 22AWG	22	FT	
250 0451 000	CABLE, 12C 18AWG	7.500	FT	
2520004000A	*WIRE, STRD 18AWG YELLOW	155	FT	
2520004000B	*WIRE, STRD 18AWG YELLOW	155	FT	
2520006000A	*WIRE, STRD 14AWG BLU	55	FT	
2520007000A	*WIRE, STRD 12AWG WHT	35	FT	
354 0005 000	TERM LUG RED SPADE 6	11	EA	
354 0010 000	LUG #10 RING BLU 16-14AWG	25	EA	
354 0015 000	LUG BLUE SPADE 6	5	EA	
354 0028 000	TERM LUG YEL SPADE 6	3	EA	
354 0324 000	LUG #10 RING YEL 12-10AWG	15	EA	
358 3307 000	KEYING PLUG, MTA156,FLUSH	3	EA	
358 3355 000	SPLIT RING FERRULE	4	EA	
358 3360 000	JACKSCREW 2.7L	2	EA	
358 3368 000	D CONN SHIELD PLATED	2	EA	
358 3378 000	BACKSHELL METAL CAST 15PD	2	EA	
610 1151 000	D CONN 15P PLUG	1	EA	
612 1338 000	RECP,12PIN,1RW,STRT,UNPOL	3	EA	
612 1384 000	D CONN 15P RECEPTACLE	3	EA	
618 0051 000	COAX CABLE RG58C, 50 OHM	6.600	FT	
620 1959 000	PLUG BNC RIGHT ANGLE	2	EA	
817 2150 547	CADS, FA100 PWR DIST	0		
852 9180 505	CABLE LAYOUT, FA100 PWR	0		

WARNING: Disconnect primary power prior to servicing.

Table 7-46. CABLE PAC R-DOOR AC DIST. - 952 9180 509 (B1)

Harris PN	Description	QTY	UM	Reference Designators
2520006000A	*WIRE, STRD 14AWG BLU	127.600	FT	
296 0262 000	TUBING, SHRINK 1/4 WHITE	0.250	FT	
354 0010 000	LUG #10 RING BLU 16-14AWG	3	EA	
354 0015 000	LUG BLUE SPADE 6	23	EA	
354 0796 000	CONTACT, PIN 20-14 AWG	12	EA	
612 1326 000	HOUSING, 4 PIN CONN PLUG	3	EA	
817 2150 570	CADS, PAC R-DOOR AC DIST.	0		
852 9180 509	CABLE LAYOUT (*),PAC REAR	0		

Table 7-47. FREQUENCY CONTROL BD - 992 8525 003 (B)

Harris PN	Description	QTY	UM	Reference Designators
354 0309 000	TERM SOLDER	15	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP007,JP008
358 2177 000	SPACER, LED MOUNT .380 LG	9	EA	#DS001,#DS002,#DS003,#DS004,#DS005,#DS006,#DS007,#DS008,#DS009
380 0189 000	XSTR, NPN 2N3904 ESD	1	EA	Q002
380 0708 000	XSTR MPS6652 40V 1A ESD	1	EA	Q001
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U013
382 0359 000	IC, 7815 ESD	1	EA	U012
382 0443 000	IC, CD4053BE ESD	1	EA	U008
382 0605 000	IC 7905C ESD	1	EA	U014
382 0676 000	IC, 74LS05N ESD	1	EA	U007
382 0739 000	IC 555 CMOS ESD	1	EA	U016
382 0817 000	IC, 74HC244 ESD	2	EA	U002,U004
382 0882 000	IC, 78L05A ESD	1	EA	U011
382 1084 000	IC, LP339N ESD	1	EA	U015
382 1147 000	CONVERTER A/D 3-1/2 DIGIT ESD	2	EA	U009,U010
382 1171 000	IC 74HC540 (ESD)	1	EA	U005
384 0431 000	RECT. 1N4001 ESD	6	EA	CR001,CR004,CR005,CR007,CR008,CR010
384 0610 000	* LED, GREEN T-1 3/4 ESD	1	EA	DS001
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	3	EA	DS014,DS015,DS020
384 0662 000	LED RED ESD	2	EA	DS016,DS017
384 0679 000	*LED, YELLOW T1-3/4 ESD	1	EA	DS002
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	2	EA	CR002,CR006
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR003
384 0743 000	DIODE ARRAY DUAL 8 ESD	1	EA	U001
384 0806 000	LED, BI-COLOR RED/GREEN ESD	5	EA	DS005,DS006,DS007,DS008,DS009
384 0824 000	LED DISPLAY .560 INCH ESD	4	EA	DS010,DS011,DS012,DS013
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	1	EA	CR009
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	2XF001 2XF002 2XF003
404 0511 000	SOCKET, DIP, 40 PIN (DL)	2	EA	XU009,XU010
404 0513 000	HEAT SINK PA1-1CB	1	EA	#U013
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1	EA	XU016
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3	EA	XU001,XU007,XU015
404 0675 000	SOCKET, DIP, 16 PIN (DL)	1	EA	XU008
404 0767 000	SOCKET, DIP, 20 PIN (DL)	3	EA	XU002,XU004,XU005
404 0797 000	SOCKET, DIP, 24 PIN (DL)	2	EA	XU003,XU006
500 0759 000	CAP, MICA, 100PF 500V 5%	2	EA	C008,C013
506 0244 000	CAP, 0.22UF 63V 5%	2	EA	C011,C030

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516 0453 000	CAP .1UF 100V 20% X7R	31	EA	C006,C007,C009,C012,C014,C015,C016,C017,C018,C021,C023,C024,C025,C026,C027,C029,C031,C032,C033,C034,C035,C036,C037,C038,C039,C041,C042,C043,C044,C045,C058
516 0790 000	CAP NTWK 1000PF 10% 50V	1	EA	C001
516 0792 000	CAP NETWORK .1UF 10%	5	EA	C002,C003,C004,C005,C059
516 0834 000	CAP 0.047UF 10% 50V	2	EA	C010,C028
522 0550 000	CAP 100UF 25V 20%	3	EA	C019,C020,C022
522 0570 000	CAP 2.2UF 50V 20%	1	EA	C040
540 1356 000	RES NETWORK 10K OHM 2%	1	EA	R014
540 1365 000	RES NETWORK 36 OHM 2%	7	EA	R005,R006,R007,R008,R009,R011,R062
540 1387 000	RES NETWORK 10K OHM 2%	3	EA	R001,R002,R013
540 1416 000	RES NETWORK 10K OHM 2%	1	EA	R069
540 1457 000	RES NETWORK 330 OHM 2%	1	EA	R004
540 1493 000	RES NETWORK 100K OHM	3	EA	R003,R010,R012
548 1486 000	* RES 4.99K OHM 1/2W 0.1%	2	EA	R028,R037
548 2400 169	RES 51.1 OHM 1/2W 1%	1	EA	R064
548 2400 251	RES 332 OHM 1/2W 1%	3	EA	R015,R065,R068
548 2400 254	RES 357 OHM 1/2W 1%	2	EA	R039,R058
548 2400 258	RES 392 OHM 1/2W 1%	2	EA	R046,R054
548 2400 269	RES 511 OHM 1/2W 1%	1	EA	R019
548 2400 279	RES 649 OHM 1/2W 1%	1	EA	R052
548 2400 301	RES 1K OHM 1/2W 1%	1	EA	R051
548 2400 312	RES 1.3K OHM 1/2W 1%	3	EA	R043,R049,R053
548 2400 333	RES 2.15K OHM 1/2W 1%	1	EA	R040
548 2400 334	RES 2.21K OHM 1/2W 1%	1	EA	R038
548 2400 335	RES 2.26K OHM 1/2W 1%	1	EA	R050
548 2400 347	RES 3.01K OHM 1/2W 1%	1	EA	R041
548 2400 351	RES 3.32K OHM 1/2W 1%	2	EA	R048,R055
548 2400 369	RES 5.11K OHM 1/2W 1%	2	EA	R022,R032
548 2400 401	RES 10K OHM 1/2W 1%	11	EA	R016,R017,R018,R021,R026,R029,R031,R059,R060,R061,R063
548 2400 411	RES 12.7K OHM 1/2W 1%	1	EA	R042
548 2400 447	RES 30.1K OHM 1/2W 1%	1	EA	R067
548 2400 501	RES 100K OHM 1/2W 1%	2	EA	R024,R034
548 2400 513	RES 133K OHM 1/2W 1%	1	EA	R066
548 2400 566	RES 475K OHM 1/2W 1%	4	EA	R023,R025,R033,R035
548 2400 601	RES 1MEG OHM 1/2W 1%	5	EA	R020,R030,R044,R045,R047
550 0959 000	TRIMPOT 20K OHM 1/2W 10%	2	EA	R027,R036
574 0366 000	RELAY DPDT 12VDC	1	EA	K001
604 0903 000	SWITCH, TGL SPDT MOM OFF	2	EA	S004,S005
604 0905 000	SW, PB MOMENTARY	1	EA	S003
604 0979 000	SW, THUMBWHEEL SP-16 POS	1	EA	S007
604 1089 000	SW, TGL SPDT PC MOUNT	1	EA	S002
610 0900 000	HEADER 3 CKT STRAIGHT	1	EA	JP001
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	1	EA	J003
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	2	EA	J001,J002
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J007
610 1150 000	HDR, 10C 1ROW STRAIGHT	4	EA	J004,J005,J006,J008
612 1184 000	SHUNT JUMPER 0.1" CENTERS	1	EA	#JP001
839 7930 501	SCHEM, FREQ CTRL	0		
839 7930 781	SCHEM, FREQ CTRL	0		
843 5155 501	PWB, FREQ CTRL	1		
917 2150 731	FIRMWARE, STATUS 1.0	1	EA	
917 2150 732	FIRMWARE, BAND-ENC 1.0	1	EA	
999 2704 001	HARDWARE LIST	1	EA	

WARNING: Disconnect primary power prior to servicing.

Table 7-48. FREQ CTRL INTFC BD - 992 8526 003 (A)

Harris PN	Description	QTY	UM	Reference Designators
2520002000A	*WIRE, STRD 22AWG GRN	6.700	FT	#P051
296 0253 000	TUBING, SHRINK 3/16 WHITE	0.900	FT	#P051
324 0281 000	NUT, CAPTIVE 4-40	4	EA	#Q003,#Q005
354 0309 000	TERM SOLDER	49	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023,TP024,TP025,TP026,TP027,TP028,TP029,TP030,TP031,TP032,TP033,TP034,TP035,TP036,TP037,TP038,TP039,TP040,TP041,TP042,TP043,TP044,TP045,TP046,TP047,TP048,TP049
358 1214 000	SCREWLOCK, FEMALE	6	EA	
358 2684 000	PC BD STANDOFF 4-40X.125	7	EA	#HEATSINK
358 3377 000	LOCKING POST	5	EA	#J001,#J002,#J008,#J010,#J013
380 0189 000	XSTR, NPN 2N3904 ESD	1	EA	Q004
380 0614 000	XSTR, NPN MJ11028 ESD	1	EA	Q003
380 0728 000	XSTR, NMOS IRL520 ESD	2	EA	Q001,Q002
380 0740 000	XSTR, MJ11029 PNP ESD	1	EA	Q005
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U035
382 0359 000	IC, 7815 ESD	1	EA	U037
382 0360 000	IC, 7915 ESD	1	EA	U036
382 0676 000	IC, 74LS05N ESD	1	EA	U012
382 0739 000	IC 555 CMOS ESD	1	EA	U021
382 0742 000	IC AD7524 ESD	2	EA	U026,U033
382 0749 000	IC NE5532A ESD	2	EA	U028,U031
382 0774 000	IC 74HC14 ESD	2	EA	U007,U011
382 0775 000	IC, 74HC20 ESD	1	EA	U016
382 0882 000	IC, 78L05A ESD	1	EA	U038
382 1011 000	IC, 14541/4541 ESD	1	EA	U023
382 1054 000	IC, 74HC273 ESD	1	EA	U006
382 1084 000	IC, LP339N ESD	4	EA	U009,U014,U039,U043
382 1305 000	IC, PA51 ESD	2	EA	U040,U041
382 1307 000	IC, 2597 SINK DRIVER ESD	5	EA	U001,U010,U019,U024,U030
382 1664 000	IC, OP AMP, TL054 ESD	2	EA	U042,U044
384 0431 000	RECT. 1N4001 ESD	16	EA	CR001,CR002,CR003,CR004,CR005,CR006,CR007,CR008,CR009,CR010,CR012,CR013,CR015,CR016,CR017,CR021
384 0612 000	DIODE 1N3070 ESD	5	EA	CR011,CR025,CR026,CR027,CR032
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	8	EA	DS001,DS002,DS004,DS005,DS006,DS007,DS008,DS009
384 0662 000	LED RED ESD	1	EA	DS003
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR018
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	6	EA	CR019,CR020,CR030,CR031,CR034,CR035
384 0743 000	DIODE ARRAY DUAL 8 ESD	3	EA	U003,U004,U005
384 0803 000	RECT MUR-120 200V ESD	4	EA	CR023,CR028,CR029,CR033
384 0891 000	LED 10 SEG BARGRAPH, GRN ESD	2	EA	DS10,DS011
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	1	EA	CR014
386 0137 000	ZENER, 1N4746A 18V ESD	1	EA	CR024
386 0439 000	ZENER, 1N5353B 16V 5W 5% ESD	1	EA	CR022
398 0024 000	FUSE, FAST CART 8A 250V	1	EA	F012
398 0465 000	FUSE, FAST CART 2A 250V	11	EA	F001,F002,F003,F004,F005,F006,F007,F008,F009,F010,F011
398 0472 000	FUSE, FAST CART 250V 12A	2	EA	F013,F014
402 0129 000	CLIP, 1/4 DIA FUSE	6	EA	XF012,XF013,XF014
402 0198 000	CLIP, FUSE 5MM DIA FUSE	22	EA	XF001,XF002,XF003,XF004,XF005,XF006,XF007,XF008,XF009,XF010,XF011
404 0513 000	HEAT SINK PA1-1CB	1	EA	#U035
404 0673 000	SOCKET, DIP, 8 PIN (DL)	3	EA	XU021,XU028,XU031
404 0674 000	SOCKET, DIP, 14 PIN (DL)	14	EA	

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				XU003,XU004,XU005,XU007,XU009,XU011,XU012,XU014,XU016,XU023,XU039,XU042,XU043,XU044
404 0675 000	SOCKET, DIP, 16 PIN (DL)	11	EA	XR005,XR007,XR009,XR014,XR015,XR046,XR056,XR061,XR072,XU026,XU033
404 0767 000	SOCKET, DIP, 20 PIN (DL)	8	EA	XU001,XU006,XU010,XU019,XU024,XU030 XDS010 XDS011
404 0797 000	SOCKET, DIP, 24 PIN (DL)	13	EA	XU002,XU008,XU013,XU015,XU017,XU018,XU020,XU022,XU025,XU027,XU029,XU032,XU034
410 0382 000	INSULATOR #4 SCREW	4	EA	#Q003,Q005
410 0385 000	INSULATOR TO-3 SILICON	2	EA	#Q003,#Q005
516 0453 000	CAP .1UF 100V 20% X7R	78	EA	C001,C002,C009,C010,C011,C013,C014,C015,C019,C020,C023,C025,C026,C028,C029,C030,C031,C032,C033,C034,C035,C036,C037,C038,C039,C041,C042,C043,C044,C045,C046,C047,C049,C050,C051,C052,C054,C057,C058,C059,C060,C061,C062,C064,C066,C067,C068,C069,C070,C071,C072,C073,C074,C075,C076,C077,C081,C082,C084,C086,C087,C088,C089,C090,C093,C096,C099,C100,C101,C106,C108,C109,C110,C111,C112,C113,C114,C115
516 0736 000	CAP .001UF 10% 100V X7R	5	EA	C004,C018,C024,C102,C105
516 0765 000	CAP 10PF 5% 100V C0G	2	EA	C053,C063
516 0774 000	CAP 56PF 5% 100V C0G	4	EA	C098,C103,C104,C107
516 0790 000	CAP NTWK 1000PF 10% 50V	3	EA	C003,C005,C006
516 0792 000	CAP NETWORK .1UF 10%	12	EA	C007,C008,C012,C016,C017,C021,C022,C027,C048,C055,C056,C065
522 0531 000	CAP 1UF 50V 20%	9	EA	C040,C083,C085,C091,C092,C094,C095,C097,C116
522 0550 000	CAP 100UF 25V 20%	3	EA	C078,C079,C080
540 1356 000	RES NETWORK 10K OHM 2%	3	EA	R005,R046,R056
540 1365 000	RES NETWORK 36 OHM 2%	6	EA	R007,R009,R014,R015,R061,R072
540 1378 000	RES NETWORK 5600 OHM 2%	2	EA	R068,R079
540 1380 000	RES NETWORK 10K OHM 2%	15	EA	R003,R004,R017,R051,R060,R076,R088,R093,R094,R095,R103,R104,R108,R121,R126
540 1383 000	RES NETWORK 100K OHM 2%	1	EA	R016
540 1387 000	RES NETWORK 10K OHM 2%	6	EA	R098,R100,R106,R107,R116,R129
540 1392 000	RES NETWORK 4700 OHM 2%	2	EA	R080,R099
540 1416 000	RES NETWORK 10K OHM 2%	2	EA	R064,R77
540 1422 000	RES NETWORK 330 OHM 2%	2	EA	R040,R044
540 1492 000	RES NETWORK 1.8K 9 SIP	1	EA	R130
540 1493 000	RES NETWORK 100K OHM	1	EA	R047
540 1496 000	RES NETWORK 100 OHM	2	EA	R105,R120
540 1600 212	RES 300 OHM 3W 5%	2	EA	R127,R164
542 1631 000	RES 0.075 OHM 5W 5%	4	EA	R043,R062,R089,R092
548 0393 001	RES 0.5 OHM 1W 1%	2	EA	R502,R503
548 2400 042	RES 2.67 OHM 1/2W 1%	29	EA	R134,R135,R136,R137,R138,R139,R140,R141,R142,R143,R144,R145,R146,R147,R148,R149,R150,R151,R152,R153,R154,R155,R156,R157,R158,R159,R160,R161,R162
548 2400 155	RES 36.5 OHM 1/2W 1%	6	EA	R011,R013,R018,R070,R085,R087
548 2400 169	RES 51.1 OHM 1/2W 1%	1	EA	R128
548 2400 201	RES 100 OHM 1/2W 1%	1	EA	R001
548 2400 251	RES 332 OHM 1/2W 1%	1	EA	R054
548 2400 254	RES 357 OHM 1/2W 1%	1	EA	R035
548 2400 258	RES 392 OHM 1/2W 1%	1	EA	R024
548 2400 279	RES 649 OHM 1/2W 1%	1	EA	R031
548 2400 285	RES 750 OHM 1/2W 1%	2	EA	R109,R115
548 2400 301	RES 1K OHM 1/2W 1%	6	EA	R032,R039,R045,R053,R123,R124
548 2400 312	RES 1.3K OHM 1/2W 1%	3	EA	R029,R034,R036
548 2400 318	RES 1.5K OHM 1/2W 1%	2	EA	R021,R022
548 2400 333	RES 2.15K OHM 1/2W 1%	1	EA	R027
548 2400 335	RES 2.26K OHM 1/2W 1%	1	EA	R033

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548 2400 343	RES 2.74K OHM 1/2W 1%	3	EA	R057,R058,R059
548 2400 347	RES 3.01K OHM 1/2W 1%	1	EA	R028
548 2400 351	RES 3.32K OHM 1/2W 1%	1	EA	R111
548 2400 364	RES 4.53K OHM 1/2W 1%	1	EA	R125
548 2400 377	RES 6.19K OHM 1/2W 1%	1	EA	R084
548 2400 401	RES 10K OHM 1/2W 1%	34	EA	R006,R008,R010,R012,R019,R020,R023,R037,R042,R048,R050,R052,R055,R067,R071,R082,R083,R102,R110,R113,R114,R117,R118,R119,R122,R132,R133,R163,R165,R501,R504,R508,R515,R516
548 2400 411	RES 12.7K OHM 1/2W 1%	1	EA	R112
548 2400 425	RES 17.8K OHM 1/2W 1%	1	EA	R096
548 2400 449	RES 31.6K OHM 1/2W 1%	1	EA	R065
548 2400 466	RES 47.5K OHM 1/2W 1%	2	EA	R074,R075
548 2400 469	RES 51.1K OHM 1/2W 1%	1	EA	R086
548 2400 477	RES 61.9K OHM 1/2W 1%	1	EA	R066
548 2400 501	RES 100K OHM 1/2W 1%	3	EA	R041,R049,R101
548 2400 538	RES 243K OHM 1/2W 1%	2	EA	R063,R097
548 2400 547	RES 301K OHM 1/2W 1%	3	EA	R002,R038,R069
548 2400 601	RES 1MEG OHM 1/2W 1%	3	EA	R025,R026,R030
550 0858 000	TRIMPOT 5K OHM 1/2W 10%	2	EA	R510,R512
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	4	EA	R073,R081,R511,R513
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2	EA	R090,R091
574 0366 000	RELAY DPDT 12VDC	1	EA	K001
610 0870 000	PLUG, NON-INS SHORTING	40	EA	8#JP006 8#JP007 8#JP008 8#JP010 8#JP011
610 0900 000	HEADER 3 CKT STRAIGHT	4	EA	JP002,JP003,JP004,JP009
610 0947 000	RECP, D, 15 PIN, RT ANG	2	EA	J001,J008
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	3	EA	J009,J017,J018
610 0991 000	HDR, STR, 6 PIN, 0.025 SQ	6	EA	J051,J052,J053,J054,J055,J056
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	4	EA	J015,J016,J019,J020
610 1098 000	HDR, 4 PIN IN-LINE	1	EA	J014
610 1107 000	HDR,12PIN,1ROW,STRT,POL	2	EA	J011,J012
610 1156 000	PLUG 15P D STRT PCB	3	EA	J002,J010,J013
612 0784 000	RECP 9 CONT	6	EA	J003,J004,J005,J006,J007,J021
612 1162 000	HOUSING 6 CKT	2	EA	#P051
612 1176 000	DIP STRIP, FEMALE 10 POS	5	EA	JP006,JP007,JP008,JP010,JP011
612 1184 000	SHUNT JUMPER 0.1" CENTERS	4	EA	#JP002,#JP003,#JP004,#JP009
612 1369 000	JACK, PCB MT, .051 PIN	20	EA	2#Q003 2#Q005 8#U040 8#U041
843 5155 502	PWB, FREQ CTRL INTFC	1		
843 5155 844	SCHEM, FREQ CTRL INTFC	0		
917 2150 561	STANDOFF	18	EA	2#J002 2#J003 2#J004 2#J005 2#J006 2#J007 2#J010 2#J013 2#J021
917 2150 736	FIRMWARE, TX-CTRL 2.0	1	EA	U015
917 2150 737	FIRMWARE, SERVO 1.0	1	EA	U018
917 2150 738	FIRMWARE, REF-CNT 1.0	1	EA	U027,U034
917 2150 739	FIRMWARE, P-DRIVER 1.0	1	EA	U002
917 2150 740	FIRMWARE, DRIVER 2.0	1	EA	U008
917 2150 742	FIRMWARE, 2C2 2.0	1	EA	U025
917 2150 743	FIRMWARE, 2C3-2C4 1.0	1	EA	U032
917 2150 744	FIRMWARE, VSWR 2.0	1	EA	U029
917 2150 745	FIRMWARE, SYN-SYNC 2.0	1	EA	U013
917 2150 746	FIRMWARE, A/D 2.0	1	EA	U017
917 2150 800	FIRMWARE, COMBINER REV 2.0A,	1	EA	U020
939 7930 609	FREQ CTRL INTFC HS	1	EA	
999 2703 001	HARDWARE LIST	1	EA	

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Table 7-49. DRIVER ENCODER BD, - 992 8537 005 (A)

Harris PN	Description	QTY	UM	Reference Designators
354 0309 000	TERM SOLDER	23	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015,TP016,TP017,TP018,TP019,TP020,TP021,TP022,TP023
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP012,JP013
380 0125 000	XSTR, NPN 2N4401 ESD	6	EA	Q004,Q005,Q006,Q007,Q008,Q009
380 0653 000	XSTR, NPN MPS6602 ESD	1	EA	Q003
380 0728 000	XSTR, NMOS IRL520 ESD	1	EA	Q001
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U030
382 0359 000	IC, 7815 ESD	1	EA	U029
382 0415 000	IC, 324 ESD	1	EA	U025
382 0594 000	*IC TL074ACN ESD	2	EA	U019,U020
382 0605 000	IC 7905C ESD	1	EA	U031
382 0774 000	IC 74HC14 ESD	4	EA	U012,U013,U016,U024
382 0817 000	IC, 74HC244 ESD	1	EA	U022
382 0882 000	IC, 78L05A ESD	1	EA	U033
382 1084 000	IC, LP339N ESD	7	EA	U002,U014,U015,U017,U026,U027,U032
382 1112 000	IC, 74HCT74N ESD	1	EA	U021
382 1204 000	IC TC4423 ESD	9	EA	U003,U004,U005,U006,U008,U009,U010,U011,U023
384 0321 000	*DIODE 5082-2800 ESD	2	EA	CR006,CR007
384 0431 000	RECT. 1N4001 ESD	5	EA	CR011,CR012,CR013,CR016,CR017
384 0612 000	DIODE 1N3070 ESD	7	EA	CR001,CR003,CR004,CR005,CR010,CR021,CR023
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	3	EA	DS004,DS005,DS006
384 0662 000	LED RED ESD	4	EA	DS001,DS002,DS007,DS008
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	4	EA	CR008,CR015,CR018,CR019
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR014
384 0847 000	*LED 10 SEG BARGRAPH, GRN ESD	1	EA	DS003
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	3	EA	CR009,CR020,CR025
386 0100 000	ZENER, 1N4747A 20V ESD	2	EA	CR022,CR024
386 0135 000	ZENER, 1N4733A 5.1V ESD	1	EA	CR002
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	2XF001 2XF002 2XF003
404 0513 000	HEAT SINK PA1-1CB	3	EA	#U029,#U030,#U031
404 0673 000	SOCKET, DIP, 8 PIN (DL)	9	EA	XU003,XU004,XU005,XU006,XU008,XU009,XU010,XU011,XU023
404 0674 000	SOCKET, DIP, 14 PIN (DL)	15	EA	XU002,XU012,XU013,XU014,XU015,XU016,XU017,XU019,XU020,XU021,XU024,XU025,XU026,XU027,XU032
404 0675 000	SOCKET, DIP, 16 PIN (DL)	2	EA	#S002,#S003
404 0767 000	SOCKET, DIP, 20 PIN (DL)	2	EA	#DS003,XU022
404 0797 000	SOCKET, DIP, 24 PIN (DL)	3	EA	XU001,XU007,XU018
484 0415 000	LINE, DELAY 20-620NS ESD	1	EA	U018
494 0392 000	CHOKE RF 4.70UH	1	EA	L006
494 0404 000	CHOKE RF 33.0UH	2	EA	L004,L005
500 0753 000	CAP, MICA, 56PF 500V 5%	3	EA	C056,C057,C058
500 0852 000	CAP, MICA, 1000PF 500V 5%	1	EA	C026
500 0903 000	CAP, MICA, 2700PF 500V 5%	3	EA	C031,C032,C042
500 1227 000	CAP, MICA, 6800PF 100V 5%	1	EA	C004
506 0235 000	CAP .0033UF 100V 5%	15	EA	C001,C003,C005,C006,C007,C008,C009,C010,C014,C015,C016,C017,C018,C019,C020
516 0453 000	CAP .1UF 100V 20% X7R	57	EA	C002,C022,C028,C029,C033,C037,C039,C040,C041,C043,C046,C049,C051,C052,C053,C054,C061,C064,C065,C066,C067,C069,C070,C071,C073,C074,C077,C078,C079,C080,C081,C082,C083,C084,C085,C086,C087,C088,C089,C090,C091,C092,C093,C094,C095,C096,C097,C098,C099,C100,C101,C102,C103,C104,C105,C106,C107
516 0530 000	CAP .01UF 10% 100V X7R	7	EA	C012,C027,C034,C048,C055,C059,C062

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516 0736 000	CAP .001UF 10% 100V X7R	1	EA	C021
516 0792 000	CAP NETWORK .1UF 10%	2	EA	C030,C038
522 0561 000	CAP 100UF 63V 20%	5	EA	C023,C068,C072,C075,C076
526 0050 000	CAP 1UF 35V 20%	4	EA	C047,C050,C060,C063
526 0097 000	CAP 47UF 35V 20%	2	EA	C024,C025
526 0106 000	CAP 27UF 35V 10%	1	EA	C035
526 0358 000	CAP 22UF 35V 10%	1	EA	C036
540 1365 000	RES NETWORK 36 OHM 2%	1	EA	R003
540 1366 000	RES NETWORK 100 OHM 2%	1	EA	R030
540 1380 000	RES NETWORK 10K OHM 2%	14	EA	R005,R006,R007,R008,R028,R029,R076,R077,R114,R117,R132,R134,R146,R157
540 1383 000	RES NETWORK 100K OHM 2%	2	EA	R004,R133
540 1416 000	RES NETWORK 10K OHM 2%	1	EA	R072
540 1443 000	RES NETWORK 27 OHM 2%	1	EA	R144
540 1460 000	RES NETWORK 510 OHM 2%	1	EA	R009
540 1493 000	RES NETWORK 100K OHM	3	EA	R018,R032,R042
540 1496 000	RES NETWORK 100 OHM	1	EA	R115
540 1600 105	RES 15 OHM 3W 5%	1	EA	R109
540 1600 201	RES 100 OHM 3W 5%	1	EA	R108
540 1600 205	RES 150 OHM 3W 5%	1	EA	R061
540 1600 213	RES 330 OHM 3W 5%	2	EA	R066,R106
548 2400 126	RES 18.2 OHM 1/2W 1%	1	EA	R051
548 2400 158	RES 39.2 OHM 1/2W 1%	15	EA	R001,R011,R014,R016,R019,R021,R023,R026,R031,R034,R036,R038,R040,R043,R045
548 2400 169	RES 51.1 OHM 1/2W 1%	3	EA	R078,R090,R093
548 2400 201	RES 100 OHM 1/2W 1%	21	EA	R002,R013,R015,R017,R020,R022,R024,R025,R033,R035,R037,R039,R041,R044,R046,R047,R113,R128,R150,R155,R184
548 2400 254	RES 357 OHM 1/2W 1%	4	EA	R124,R125,R164,R167
548 2400 258	RES 392 OHM 1/2W 1%	1	EA	R176
548 2400 269	RES 511 OHM 1/2W 1%	4	EA	R012,R111,R112,R182
548 2400 279	RES 649 OHM 1/2W 1%	1	EA	R173
548 2400 285	RES 750 OHM 1/2W 1%	1	EA	R082
548 2400 301	RES 1K OHM 1/2W 1%	8	EA	R053,R055,R074,R75,R105,R120,R171,R179
548 2400 312	RES 1.3K OHM 1/2W 1%	2	EA	R159,R174
548 2400 330	RES 2K OHM 1/2W 1%	1	EA	R73
548 2400 334	RES 2.21K OHM 1/2W 1%	2	EA	R162,R165
548 2400 340	RES 2.55K OHM 1/2W 1%	1	EA	R168
548 2400 351	RES 3.32K OHM 1/2W 1%	3	EA	R161,R163,R166
548 2400 359	RES 4.02K OHM 1/2W 1%	2	EA	R118,R123
548 2400 369	RES 5.11K OHM 1/2W 1%	1	EA	R050
548 2400 373	RES 5.62K OHM 1/2W 1%	1	EA	R081
548 2400 377	RES 6.19K OHM 1/2W 1%	1	EA	R088
548 2400 381	RES 6.81K OHM 1/2W 1%	1	EA	R095
548 2400 385	RES 7.5K OHM 1/2W 1%	1	EA	R083
548 2400 388	RES 8.06K OHM 1/2W 1%	1	EA	R136
548 2400 401	RES 10K OHM 1/2W 1%	32	EA	R049,R052,R054,R056,R057,R058,R059,R060,R065,R069,R080,R089,R091,R092,R094,R098,R099,R101,R102,R103,R104,R110,R119,R126,R127,R130,R156,R158,R175,R178,R181,R183
548 2400 413	RES 13.3K OHM 1/2W 1%	1	EA	R160
548 2400 418	RES 15K OHM 1/2W 1%	2	EA	R064,R135
548 2400 451	RES 33.2K OHM 1/2W 1%	2	EA	R177,R180
548 2400 462	RES 43.2K OHM 1/2W 1%	1	EA	R085
548 2400 466	RES 47.5K OHM 1/2W 1%	2	EA	R096,R097
548 2400 469	RES 51.1K OHM 1/2W 1%	1	EA	R087
548 2400 493	RES 90.9K OHM 1/2W 1%	4	EA	R116,R139,R147,R152

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548 2400 501	RES 100K OHM 1/2W 1%	7	EA	R027,R048,R071,R121,R122,R131,R137
548 2400 530	RES 200K OHM 1/2W 1%	1	EA	R079
548 2400 601	RES 1MEG OHM 1/2W 1%	5	EA	R063,R068,R169,R170,R172
550 0949 000	TRIMPOT 100K OHM 1/2W 10%	1	EA	R086
550 0958 000	TRIMPOT 10K OHM 1/2W 10%	2	EA	R084,R100
578 0026 000	RELAY DPDT 12VDC 2 AMP	1	EA	K001
600 0579 000	SW, ROTARY 4PDT	2	EA	S002,S003
604 0904 000	SW, TGL SPDT	1	EA	S001
610 0870 000	PLUG, NON-INS SHORTING	16	EA	8#JP002 8#JP003
610 0900 000	HEADER 3 CKT STRAIGHT	2	EA	JP001,JP009
610 0979 000	*HDR 10C VERT 2ROW TOP LATCH	1	EA	J008
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	2	EA	J001,J002
610 1027 000	HEADER, MALE 12 PIN	1	EA	J007
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	3	EA	J003,J004,J009
610 1106 000	HDR, 8PIN, 1ROW, STRT,POL	1	EA	J005
612 1176 000	DIP STRIP, FEMALE 10 POS	2	EA	JP002,JP003
612 1184 000	SHUNT JUMPER 0.1" CENTERS	2	EA	#JP001,#JP009
620 0515 000	RECP, SCREW ON SMC	1	EA	J006
843 5155 510	PWB, DRIVER ENCODER	1		
843 5155 846	SCHEMATIC, DRIVER ENCODER	0		
917 2150 733	FIRMWARE, LEFT DRIVERS	1	EA	
917 2150 734	FIRMWARE, RIGHT DRIVERS	1	EA	
922 0922 156	TRANSFORMER	1	EA	T001
999 2708 001	HARDWARE LIST	1	EA	

Table 7-50. XMTR INTERFACE BD, - 992 8540 003 (A)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	15	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014,TP015
358 1928 000	JUMPER 1/4 LG 1/8H	3	EA	JP051,JP052,JP056
358 2997 000	END PLATE,236 TERM MODULE	1	EA	#TB001
358 3327 000	BATTERY HOLDER, 4 AA CELL	1	EA	#B001
380 0189 000	XSTR, NPN 2N3904 ESD	1	EA	Q001
380 0678 000	*XSTR, ARRAY QUAD 2222 ESD	1	EA	U006
382 0749 000	IC NE5532A ESD	2	EA	U001,U002
382 0773 000	IC 74HC11 ESD	1	EA	U003
382 0817 000	IC, 74HC244 ESD	1	EA	U004
382 1174 000	IC, 696 ESD	1	EA	U005
384 0431 000	RECT. 1N4001 ESD	7	EA	CR007,CR012,CR013,CR014,CR015,CR016,CR017
384 0612 000	DIODE 1N3070 ESD	6	EA	CR001,CR002,CR003,CR004,CR005,CR006
384 0662 000	LED RED ESD	2	EA	DS001,DS002
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR018
384 0838 000	TRANSZORB 1N6380 36V 5W ESD	2	EA	CR008,CR009
386 0123 000	ZENER, 1N4732A 4.7V ESD	2	EA	CR010,CR011
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2	EA	XU001,XU002
404 0674 000	SOCKET, DIP, 14 PIN (DL)	2	EA	XU003,XU006
404 0675 000	SOCKET, DIP, 16 PIN (DL)	1	EA	XU005
404 0767 000	SOCKET, DIP, 20 PIN (DL)	1	EA	XU004
442 0116 000	THERMOSTAT, 70 DEG C +/-5	1	EA	S002
506 0230 000	CAP .001UF 100VAC 5%	2	EA	C002,C003
516 0453 000	CAP .1UF 100V 20% X7R	12	EA	C004,C005,C006,C007,C008,C009,C010,C011,C012,C014,C015,C020
516 0792 000	CAP NETWORK .1UF 10%	1	EA	C001
526 0374 000	CAP 1.0F 5.5V	1	EA	C013
540 0308 000	*RES 100 OHM 1W 10%	1	EA	R043

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540 0563 000	*RES 10 OHM 2W 10%	1	EA	R041
540 0587 000	*RES 100 OHM 2W 10%	2	EA	R042,R047
540 1365 000	RES NETWORK 36 OHM 2%	2	EA	R012,R013
540 1380 000	RES NETWORK 10K OHM 2%	1	EA	R033
540 1416 000	RES NETWORK 10K OHM 2%	1	EA	R005
540 1421 000	RES NETWORK 4700 OHM 2%	1	EA	R045
540 1427 000	RES NETWORK 4700 OHM 2%	1	EA	R007
540 1493 000	RES NETWORK 100K OHM	1	EA	R008
548 2400 301	RES 1K OHM 1/2W 1%	3	EA	R006,R048,R051
548 2400 330	RES 2K OHM 1/2W 1%	3	EA	R044,R046,R049
548 2400 369	RES 5.11K OHM 1/2W 1%	1	EA	R011
548 2400 401	RES 10K OHM 1/2W 1%	10	EA	R001,R004,R014,R019,R024,R029,R031,R032,R034,R035
548 2400 447	RES 30.1K OHM 1/2W 1%	6	EA	R017,R018,R022,R023,R027,R028
548 2400 449	RES 31.6K OHM 1/2W 1%	1	EA	R025
548 2400 485	RES 75K OHM 1/2W 1%	2	EA	R037,R038
548 2400 501	RES 100K OHM 1/2W 1%	9	EA	R009,R010,R020,R021,R030,R036,R039,R040,R052
548 2400 547	RES 301K OHM 1/2W 1%	3	EA	R015,R016,R026
604 1070 000	SWITCH, PB MOM 3P	1	EA	S001
610 0900 000	HEADER 3 CKT STRAIGHT	1	EA	JP001
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	2	EA	J019,J022
610 0979 000	*HDR 10C VERT 2ROW TOP LATCH	1	EA	J011
610 0980 000	*HDR 20C RT ANG 2ROW TOP LATCH	1	EA	J025
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	2	EA	J005,J006
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	9	EA	J001,J004,J010,J012,J013,J014,J015,J017,J018
610 1107 000	HDR,12PIN,1ROW,STRT,POL	4	EA	J007,J008,J009,J016
610 1117 000	HDR 10C 1 ROW STRAIGHT	3	EA	J020,J021,J023
612 1184 000	SHUNT JUMPER 0.1" CENTERS	3	EA	#JP001
614 0790 000	TERM MODULE,1C PC MTG 236	2	EA	TB001
620 0515 000	RECP, SCREW ON SMC	3	EA	J002,J003,J024
843 5155 512	PWB, XMTR INTERFACE	1		
843 5155 847	SCHEMATIC, XMTR INTERFACE	0		
999 2712 001	HARDWARE LIST	1	EA	

Table 7-51. SYNTHESIZER INTERFACE BD - 992 8588 001 (R)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	14	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP013,TP014
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP010,JP011
358 3314 000	STANDOFF 4-40 X .250 L	2	EA	
380 0083 000	XSTR, 2N2369 ESD	2	EA	Q003,Q005
380 0126 000	XSTR, PNP 2N4403 ESD	1	EA	Q004
380 0728 000	XSTR, NMOS IRL520 ESD	1	EA	Q001
382 0174 000	IC, MC4044P ESD	1	EA	U008
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U015
382 0262 000	IC, SN7414N ESD	1	EA	U013
382 0359 000	IC, 7815 ESD	1	EA	U016
382 0360 000	IC, 7915 ESD	1	EA	U007
382 0594 000	*IC TL074ACN ESD	1	EA	U014
382 0774 000	IC 74HC14 ESD	1	EA	U012
382 0817 000	IC, 74HC244 ESD	3	EA	U001,U002,U006
382 1054 000	IC, 74HC273 ESD	2	EA	U009,U010
382 1077 000	IC 301 ANALOG SWITCH SPDT ESD	1	EA	U004
382 1204 000	IC TC4423 ESD	2	EA	U003,U005
384 0431 000	RECT. 1N4001 ESD	3	EA	CR001,CR004,CR014

WARNING: Disconnect primary power prior to servicing.

384 0612 000	DIODE 1N3070 ESD	7	EA	CR005,CR006,CR007,CR008,CR009,CR010,CR015
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	2	EA	DS001,DS002
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	1	EA	CR002
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR003
384 0823 000	LED 10 SEG BARGRAPH, RED ESD	1	EA	DS003
386 0429 000	ZENER 1N5346A 9.1V 5W 10% ESD	1	EA	CR013
398 0465 000	FUSE, FAST CART 2A 250V	3	EA	F001,F002,F003
402 0198 000	CLIP, FUSE 5MM DIA FUSE	6	EA	2-XF001 2-XF002 2-XF003
404 0513 000	HEAT SINK PA1-1CB	2	EA	#U015,#U016
404 0673 000	SOCKET, DIP, 8 PIN (DL)	2	EA	XU003,XU005
404 0674 000	SOCKET, DIP, 14 PIN (DL)	5	EA	XU004,XU008,XU012,XU013,XU014
404 0675 000	SOCKET, DIP, 16 PIN (DL)	4	EA	XR002,XR003,XR030,XS001
404 0767 000	SOCKET, DIP, 20 PIN (DL)	6	EA	XU001,XU002,XU006,XU009,XU010 XDS003
404 0797 000	SOCKET, DIP, 24 PIN (DL)	2	EA	XU011,XU018
484 0415 000	LINE, DELAY 20-620NS ESD	1	EA	U018
500 0845 000	CAP, MICA, 2000PF 500V 5%	1	EA	C004
506 0230 000	CAP .001UF 100VAC 5%	3	EA	C017,C018,C039
516 0453 000	CAP .1UF 100V 20% X7R	26	EA	C003,C005,C007,C009,C010,C012,C014,C015,C016,C019,C020,C021,C022,C023,C024,C025,C026,C027,C029,C030,C031,C033,C034,C035,C040,C043
516 0736 000	CAP .001UF 10% 100V X7R	1	EA	C032
516 0792 000	CAP NETWORK .1UF 10%	3	EA	C001,C002,C038
522 0550 000	CAP 100UF 25V 20%	2	EA	C006,C028
526 0106 000	CAP 27UF 35V 10%	2	EA	C041,C042
526 0108 000	CAP 4.7UF 35V 20%	1	EA	C008
526 0342 000	CAP 2.7UF 35V 10%	1	EA	C036
540 0573 000	*RES 27 OHM 2W 10%	1	EA	R039
540 1356 000	RES NETWORK 10K OHM 2%	2	EA	R002,R003
540 1366 000	RES NETWORK 100 OHM 2%	1	EA	R030
540 1380 000	RES NETWORK 10K OHM 2%	1	EA	R010
540 1460 000	RES NETWORK 510 OHM 2%	1	EA	R006
540 1493 000	RES NETWORK 100K OHM	3	EA	R001,R032,R035
546 0295 000	RES 50 OHM 3.25W 5%	4	EA	R013,R017,R031,R038
546 0322 000	RES 100 OHM 3.25W 5%	1	EA	R037
548 2400 155	RES 36.5 OHM 1/2W 1%	3	EA	R004,R060,R061
548 2400 169	RES 51.1 OHM 1/2W 1%	2	EA	R029,R064
548 2400 201	RES 100 OHM 1/2W 1%	3	EA	R005,R022,R025
548 2400 234	RES 221 OHM 1/2W 1%	2	EA	R028,R036
548 2400 254	RES 357 OHM 1/2W 1%	1	EA	R011
548 2400 269	RES 511 OHM 1/2W 1%	1	EA	R007
548 2400 289	RES 825 OHM 1/2W 1%	1	EA	R062
548 2400 301	RES 1K OHM 1/2W 1%	8	EA	R015,R016,R026,R027,R044,R050,R053,R063
548 2400 312	RES 1.3K OHM 1/2W 1%	1	EA	R012
548 2400 334	RES 2.21K OHM 1/2W 1%	1	EA	R023
548 2400 366	RES 4.75K OHM 1/2W 1%	1	EA	R034
548 2400 369	RES 5.11K OHM 1/2W 1%	2	EA	R049,R051
548 2400 373	RES 5.62K OHM 1/2W 1%	1	EA	R024
548 2400 401	RES 10K OHM 1/2W 1%	12	EA	R008,R009,R019,R021,R033,R043,R045,R054,R055,R056,R057,R059
548 2400 412	RES 13K OHM 1/2W 1%	2	EA	R048,R052
548 2400 430	RES 20K OHM 1/2W 1%	1	EA	R014
548 2400 501	RES 100K OHM 1/2W 1%	2	EA	R046,R058
548 2400 601	RES 1MEG OHM 1/2W 1%	2	EA	R018,R020
578 0026 000	RELAY DPDT 12VDC 2 AMP	1	EA	K001
600 0579 000	SW, ROTARY 4PDT	1	EA	S001
610 0777 000	OBS, USE FFF 610-1455-000	1		J003

WARNING: Disconnect primary power prior to servicing.

610 0900 000	HEADER 3 CKT STRAIGHT	3	EA	JP001,JP002,JP003
610 0979 000	*HDR 10C VERT 2ROW TOP LATCH	1	EA	J007
610 0999 000	HDR, 10 PIN, PC BD	2	EA	J001,J004
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	1	EA	J006
612 1184 000	SHUNT JUMPER 0.1" CENTERS	3	EA	#JP001,#JP002,#JP003
612 1382 000	CONN, EDGECARD 44C 2 ROW	1	EA	J008
620 1677 000	RECEPTACLE, PC MT, BNC	2	EA	J002,J005
839 7930 508	SCHEMATIC, SYNTHESIZER	0		
843 5155 508	PWB,SYNTHESIZER INTERFACE	1		
917 2150 730	FIRMWARE, SYN-FLT 1.0	1	EA	
999 2706 001	HARDWARE LIST	1	EA	

Table 7-52. RF INTERFACE BD, - 992 8629 001 (G)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	13	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP009,TP010,TP011,TP012,TP016
358 1726 000	SPRING, HOLD DOWN	1	EA	#K001
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP050,JP052
380 0125 000	XSTR, NPN 2N4401 ESD	1	EA	Q001
382 0184 000	IC, 340T-5/7805 +5V REG ESD	1	EA	U003
382 0359 000	IC, 7815 ESD	1	EA	U004
382 1084 000	IC, LP339N ESD	1	EA	U002
382 1204 000	IC TC4423 ESD	1	EA	U001
384 0431 000	RECT. 1N4001 ESD	3	EA	CR002,CR009,CR010
384 0612 000	DIODE 1N3070 ESD	1	EA	CR008
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	4	EA	DS001,DS002,DS003,DS004
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR007
386 0082 000	ZENER, 1N4744A 15V 1W 5% ESD	1	EA	CR003
386 0135 000	ZENER, 1N4733A 5.1V ESD	2	EA	CR001,CR006
398 0465 000	FUSE, FAST CART 2A 250V	1	EA	F001
402 0198 000	CLIP, FUSE 5MM DIA FUSE	2	EA	2XF001
404 0161 000	SOCKET RELAY 9KH2	1	EA	XK001
404 0513 000	HEAT SINK PA1-1CB	2	EA	#U003,#U004
404 0673 000	SOCKET, DIP, 8 PIN (DL)	1	EA	XU001
404 0674 000	SOCKET, DIP, 14 PIN (DL)	1	EA	XU002
506 0232 000	CAP, 0.01UF 100V 5%	3	EA	C015,C016,C017
506 0233 000	CAP, 0.1UF 63V 5%	1	EA	C018
516 0453 000	CAP .1UF 100V 20% X7R	6	EA	C002,C003,C004,C005,C006,C013
522 0548 000	CAP 10UF 50V 20%	1	EA	C001
540 0580 000	NLA, USE NFFF 540 1600 118	1	EA	R019
540 1380 000	RES NETWORK 10K OHM 2%	4	EA	R008,R009,R011,R017
548 2400 251	RES 332 OHM 1/2W 1%	1	EA	R016
548 2400 301	RES 1K OHM 1/2W 1%	2	EA	R007,R014
548 2400 318	RES 1.5K OHM 1/2W 1%	1	EA	R018
548 2400 334	RES 2.21K OHM 1/2W 1%	2	EA	R021,R022
548 2400 401	RES 10K OHM 1/2W 1%	1	EA	R020
548 2400 434	RES 22.1K OHM 1/2W 1%	2	EA	R013,R024
548 2400 466	RES 47.5K OHM 1/2W 1%	2	EA	R010,R012
574 0156 000	RELAY 12VDC 4PDT	1	EA	K001
604 1089 000	SW, TGL SPDT PC MOUNT	1	EA	S002
610 0679 000	PLUG, SHORTING, .25" CTRS	2	EA	JP001,JP002
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	3	EA	J010,J011,J012
610 0999 000	HDR, 10 PIN, PC BD	2	EA	J003,J008
610 1106 000	HDR, 8PIN, 1ROW, STRT,POL	3	EA	J001,J002,J009

WARNING: Disconnect primary power prior to servicing.

612 0904 000	JACK, PC MT GOLD PLATED	6	EA	3JP001 3JP002
620 0515 000	RECP, SCREW ON SMC	1	EA	J007
620 1677 000	RECEPTACLE, PC MT, BNC	1	EA	J004
839 7930 515	SCHEM, RF INTERFACE BD.	0		
843 5155 515	PWB, RF INTERFACE BD.	1		
999 2752 001	HARDWARE LIST, RF INTERFC	1	EA	

Table 7-53. EXTERNAL INTERFACE BD, - 992 8631 001 (G)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	12	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008,TP011,TP012,TP013,TP014
358 1928 000	JUMPER 1/4 LG 1/8H	7	EA	JP002,JP005,JP006,JP007,JP009,JP014,JP015
358 2997 000	END PLATE,236 TERM MODULE	1	EA	#TB001
358 3377 000	LOCKING POST	6	EA	#J001,#J002,#J003,#J004,#J005,#J006
358 3411 000	STANDOFF 4-40 X .437 L	12	EA	2-#J001 2-#J002 2-#J003 2-#J004 2-#J005 2-#J006
380 0125 000	XSTR, NPN 2N4401 ESD	1	EA	Q001
382 0184 000	IC, 340T-5/7805 +5V REG ESD	2	EA	U003,U005
382 0359 000	IC, 7815 ESD	2	EA	U002,U004
382 0360 000	IC, 7915 ESD	1	EA	U001
382 0594 000	*IC TL074ACN ESD	4	EA	U006,U007,U009,U010
382 0774 000	IC 74HC14 ESD	1	EA	U018
382 1070 000	IC, ILQ-1 OPTO-ISOLATOR ESD	3	EA	U017,U019,U020
382 1307 000	IC, 2597 SINK DRIVER ESD	3	EA	U012,U014,U016
384 0431 000	RECT. 1N4001 ESD.	13	EA	CR001,CR002,CR003,CR004,CR005,CR006,CR010,CR011,CR018,CR019,CR021,CR022,CR025
384 0612 000	DIODE 1N3070 ESD	2	EA	CR014,CR016
384 0661 000	LED, GRN, T 1-3/4, RT ANG ESD	3	EA	DS001,DS002,DS003
384 0662 000	LED RED ESD	2	EA	DS004,DS005
384 0719 000	TRANSZORB 1N6373 5V 5W ESD	2	EA	CR008,CR009
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	5	EA	CR007,CR012,CR013,CR015,CR020
384 0743 000	DIODE ARRAY DUAL 8 ESD.	5	EA	U008,U011,U013,U015,U022
384 0799 000	DIODE, BIPOLAR ESD	2	EA	CR023,CR024
398 0465 000	FUSE, FAST CART 2A 250V	2	EA	F001,F002
402 0198 000	CLIP, FUSE 5MM DIA FUSE	4	EA	XF001,XF002
404 0513 000	HEAT SINK PA1-1CB	2	EA	#U004,#U005
404 0674 000	SOCKET, DIP, 14 PIN (DL).	10	EA	XU006,XU007,XU008,XU009,XU010,XU011,XU013,XU015,XU018,XU022
404 0675 000	SOCKET, DIP, 16 PIN (DL).	3	EA	XU017,XU019,XU020
404 0767 000	SOCKET, DIP, 20 PIN (DL).	3	EA	XU012,XU014,XU016
500 0837 000	CAP, MICA, 510PF 500V 5%	2	EA	C026,C029
516 0453 000	CAP .1UF 100V 20% X7R.	26	EA	C001,C002,C003,C004,C005,C006,C007,C008,C009,C020,C021,C022,C023,C037,C038,C039,C040,C047,C048,C049,C052,C053,C055,C057,C058,C064
516 0725 000	CAP 1.0UF 50V 20%.	2	EA	C018,C025
516 0736 000	CAP .001UF 10% 100V X7R.	1	EA	C061
516 0774 000	CAP 56PF 5% 100V C0G	16	EA	C015,C016,C017,C019,C028,C030,C031,C032,C033,C034,C035,C036,C042,C043,C044,C045
516 0792 000	CAP NETWORK .1UF 10%.	7	EA	C024,C027,C041,C050,C051,C054,C059
522 0561 000	CAP 100UF 63V 20%	4	EA	C010,C011,C012,C013
526 0318 000	CAP 10UF 35V 20%	1	EA	C014
540 1357 000	RES NETWORK 1000 OHM 2%	2	EA	R021,R022
540 1370 000	RES NETWORK 220 OHM 2%	2	EA	R047,R082
540 1375 000	RES NETWORK 1000 OHM 2%	1	EA	R038
540 1380 000	RES NETWORK 10K OHM 2%.	5	EA	R017,R018,R041,R044,R066
540 1383 000	RES NETWORK 100K OHM 2%.	1	EA	R040

WARNING: Disconnect primary power prior to servicing.

540 1386 000	RES NETWORK 10K OHM 2%	2	EA	R064,R076
540 1391 000	RES NETWORK 220 OHM 2%	2	EA	R045,R046
540 1443 000	RES NETWORK 27 OHM 2%	1	EA	R016
540 1493 000	RES NETWORK 100K OHM	1	EA	R020
540 1496 000	RES NETWORK 100 OHM	2	EA	R068,R070
540 1530 000	RES NETWORK 10 OHM 2%	3	EA	R050,R051,R053
540 1600 101	RES 10 OHM 3W 5%	3	EA	R052,R089,R091
540 1600 204	RES 130 OHM 3W 5%	1	EA	R083
546 0295 000	RES 50 OHM 3.25W 5%	4	EA	R004,R005,R006,R007
548 2400 101	RES 10 OHM 1/2W 1%	5	EA	R036,R084,R085,R088,R090
548 2400 269	RES 511 OHM 1/2W 1%	1	EA	R003
548 2400 285	RES 750 OHM 1/2W 1%	1	EA	R025
548 2400 301	RES 1K OHM 1/2W 1%	8	EA	R013,R024,R026,R027,R028,R029,R031,R055
548 2400 318	RES 1.5K OHM 1/2W 1%	2	EA	R001,R002
548 2400 351	RES 3.32K OHM 1/2W 1%	2	EA	R074,R075
548 2400 401	RES 10K OHM 1/2W 1%	12	EA	R008,R009,R010,R012,R019,R030,R037,R039,R042,R043,R057,R059
548 2400 418	RES 15K OHM 1/2W 1%	1	EA	R011
548 2400 430	RES 20K OHM 1/2W 1%	3	EA	R014,R048,R049
548 2400 534	RES 221K OHM 1/2W 1%	1	EA	R058
548 2400 601	RES 1MEG OHM 1/2W 1%	2	EA	R015,R023
550 0961 000	TRIMPOT 50K OHM 1/2W 10%	4	EA	R032,R033,R034,R035
574 0366 000	RELAY DPDT 12VDC	1	EA	K001
610 0900 000	HEADER 3 CKT STRAIGHT	2	EA	JP003,JP010
610 0978 000	*HDR 10C RT ANG 2ROW TOP LATCH	1	EA	J011
610 0981 000	*HDR 20C VERT 2ROW TOP LATCH	1	EA	J008
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	2	EA	J007,J009
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J010
610 1112 000	HDR 4C 2R STRT NP	12	EA	P001,P002,P003,P004,P005,P006,P007,P009,P010,P011,P012,P013
612 1184 000	SHUNT JUMPER 0.1" CENTERS	14	EA	#JP003,#JP010,#P001,#P002,#P003,#P004,#P005,#P006,#P007,#P009,#P010,#P011,#P012,#P013
612 1389 000	RECEPTACLE 37P D PCBD	6	EA	J001,J002,J003,J004,J005,J006
614 0790 000	TERM MODULE,1C PC MTG 236	16	EA	TB001
839 7930 516	SCHEM, EXTERNAL INTERFACE	0		
843 5155 516	PWB, EXTERNAL INTERFACE	1		
999 2749 002	HARDWARE LIST, EXT INTER-	1	EA	

Table 7-54. POWER SUPPLY INTERFACE - 992 8643 001 (F)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
354 0309 000	TERM SOLDER	8	EA	TP001,TP002,TP003,TP004,TP005,TP006,TP007,TP008
358 1928 000	JUMPER 1/4 LG 1/8H	4	EA	JP001,JP003,JP006,JP007
358 3377 000	LOCKING POST	5	EA	#J001,#J002,#J003,#J004,#J011
380 0125 000	XSTR, NPN 2N4401 ESD	1	EA	Q002
380 0126 000	XSTR, PNP 2N4403 ESD	1	EA	Q001
382 0359 000	IC, 7815 ESD	1	EA	U012
382 0594 000	*IC TL074ACN ESD	2	EA	U010,U014
382 1070 000	IC, ILQ-1 OPTO-ISOLATOR ESD	8	EA	U001,U003,U004,U005,U006,U007,U008,U009
382 1307 000	IC, 2597 SINK DRIVER ESD	2	EA	U002,U013
384 0431 000	RECT. 1N4001 ESD	3	EA	CR002,CR003,CR004
384 0610 000	* LED, GREEN T-1 3/4 ESD	1	EA	DS001
384 0720 000	TRANSZORB 1N6377 15V 5W ESD	1	EA	CR001
384 0743 000	DIODE ARRAY DUAL 8 ESD	1	EA	U011
398 0465 000	FUSE, FAST CART 2A 250V	1	EA	F001
402 0198 000	CLIP, FUSE 5MM DIA FUSE	2	EA	2-XF001
404 0674 000	SOCKET, DIP, 14 PIN (DL)	3	EA	XU010,XU011,XU014

WARNING: Disconnect primary power prior to servicing.

404 0675 000	SOCKET, DIP, 16 PIN (DL)	21	EA	XR004,XR005,XR006,XR008,XR010,XR011,XR015,XR016,XR018,XR023,XR024,XR027,XR033,XU001,XU003,XU004,XU005,XU006,XU007,XU008,XU009
404 0767 000	SOCKET, DIP, 20 PIN (DL)	2	EA	XU002,XU013
516 0453 000	CAP .1UF 100V 20% X7R	8	EA	C003,C004,C008,C009,C010,C013,C014,C016
516 0792 000	CAP NETWORK .1UF 10%	7	EA	C001,C002,C005,C006,C007,C012,C015
522 0550 000	CAP 100UF 25V 20%	1	EA	C011
540 1356 000	RES NETWORK 10K OHM 2%	1	EA	R033
540 1365 000	RES NETWORK 36 OHM 2%	5	EA	R004,R010,R023,R024,R027
540 1380 000	RES NETWORK 10K OHM 2%	4	EA	R021,R022,R031,R032
540 1391 000	RES NETWORK 220 OHM 2%	7	EA	R005,R006,R008,R011,R015,R016,R018
548 2400 042	RES 2.67 OHM 1/2W 1%	1	EA	R003
548 2400 266	RES 475 OHM 1/2W 1%	1	EA	R030
548 2400 301	RES 1K OHM 1/2W 1%	1	EA	R025
548 2400 312	RES 1.3K OHM 1/2W 1%	1	EA	R020
548 2400 366	RES 4.75K OHM 1/2W 1%	2	EA	R001,R002
548 2400 401	RES 10K OHM 1/2W 1%	3	EA	R026,R028,R029
610 0900 000	HEADER 3 CKT STRAIGHT	3	EA	JP002,JP004,JP005
610 1043 000	*HDR 40C VERT 2ROW TOP LATCH	5	EA	J006,J007,J008,J009,J010
610 1107 000	HDR,12PIN,1ROW,STRT,POL	1	EA	J005
612 1184 000	SHUNT JUMPER 0.1" CENTERS	3	EA	#JP002,#JP004,#JP005
612 1388 000	RECEPTACLE 9P D	1	EA	J011
612 1389 000	RECEPTACLE 37P D PCBD	4	EA	J001,J002,J003,J004
839 7930 509	SCH, POWER SUPPLY INTRFC	0		
843 5155 509	PWB, PWR SUPPLY INTERFACE	1		
917 2150 561	STANDOFF	10	EA	2-#J001 2-#J002 2-#J003 2-#J004 2-#J011
999 2748 001	HARDWARE LIST, PWR SUPPLY	1	EA	

Table 7-55. PWA, DX100-3F CONTROLLER - 992 9511 588 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
000 0000 010	B/M NOTE:	0	DWG	SOFTWARE IS DEPENDANT ON APPLICATION. REFER TO 9949807016 FOR APPLICATIONS
358 1928 000	JUMPER 1/4 LG 1/8H	2	EA	JP1,JP11
358 3383 000	JUMPER, 0.1" LG, 0.125" H	13	EA	JP2,JP3,JP4,JP5,JP6,JP7,JP8,JP9,JP10,JP12,JP13,JP14,JP15
404 0675 000	SOCKET, DIP, 16 PIN (DL)	1	EA	XUK001
574 0485 000	RELAY DPDT 12VDC 2 AMP	1	EA	K1
610 1069 000	HEADER 9 PIN SINGLE ROW	1	EA	J11
610 1145 000	HDR, 6PIN, 1ROW, STRT,POL	1	EA	J13
610 1235 000	HEADER, STRAIGHT 4 PIN	1	EA	J15
610 1423 010	HDR, 10C 1ROW VERTICAL	11	EA	J1,J2,J3,J4,J5,J6,J7,J8,J9,J10,J14
612 1575 000	RECPT 9 PIN D RT ANGLE, PCB	1	EA	J12
843 5155 842	SCH, 3F CONTROLLER	0		
992 9511 589	PWA DX100-3F CONTROLLER SMT	1	EA	

Table 7-56. PWA, 3 FREQ SELECT - 992 9764 500 (A)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
384 0431 000	RECT. 1N4001 ESD	6	EA	CR1,CR2,CR3,CR4,CR5,CR6
404 0675 000	SOCKET, DIP, 16 PIN (DL)	3	EA	XK001,XK002,XK003
548 2400 257	RES 383 OHM 1/2W 1%	3	EA	R1,R2,R3
574 0485 000	RELAY DPDT 12VDC 2 AMP	3	EA	K1,K2,K3
604 1120 000	SW PB GRN MOM W/GRN LED	3	EA	S1,S2,S3
610 1423 010	HDR, 10C 1ROW VERTICAL	3	EA	J1,J2,J3

WARNING: Disconnect primary power prior to servicing.

843 5523 971	SCH, 3 FREQ SELECT	0	
843 5523 973	PWB, 3 FREQ SELECT	1	

Table 7-57. INSTALLATION KIT - 992 8642 002 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
086 0001 001	*SEALANT, MILD STRENGTH	1	EA	
302 0215 000	SCR, 1/4-20 X 3/4	20	EA	
302 0320 000	SCR, 3/8-16 X 1-1/2	12	EA	
310 0009 000	WASHER, FLAT 1/4	20	EA	
310 0011 000	WASHER, FLAT 3/8	12	EA	
314 0009 000	WASHER, SPLIT-LOCK 1/4	20	EA	
314 0011 000	WASHER, SPLIT-LOCK 3/8	12	EA	
464 0169 000	TOOL, TRIMMER ADJUSTMENT	1	EA	
464 0246 000	TOOL KIT DX100	1	EA	
614 0807 000	*INTERFACE, 37PIN, TB/"D"	3	EA	
992 8179 001	RF AMPLIFIER MODULE	1	EA	SPARE
992 8364 001	INSTALLATION KIT, DX100	1	EA	
992 9266 004	KIT, SPARE HARDWARE,	1	EA	

Table 7-58. AIR FILTER SET - 994 9511 001 (B)

Harris PN	*Description*	*QTY*	*UM*	*Reference Designators*
448 0958 000	FILTER, AIR	8	EA	
448 0959 000	FILTER, AIR	31	EA	

A.1 Introduction

This section covers the Synthesizer Interface board(s). Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal/replacement.

NOTE: Parts List for this board is in Section VII.

A.2 Function

The function of the Synthesizer Interface board is to provide a variable frequency source of RF drive that can be remotely programmed. The Synthesizer Interface board contains the circuitry to physically and electrically interface the Syntest SM-101 synthesizer card to the rest of the transmitter.

The output Synthesizer Interface board passes through the RF Interface board and is then amplified by the Buffer Amplifier. Normally, Synthesizer Interface A is selected by the RF Interface board. If optional Synthesizer Interface B is installed, it can also be selected for operation locally or by remote control.

A.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100kW with no modulation at 540 kHz carrier frequency.

A.4 Location

The Synthesizer Interface is located inside the right front PA compartment on the upper left hand side. (SEE VIEW 10)

A.5 Block Diagram Description

Refer to Sheet 1 of the schematic for the Synthesizer Interface board 839-7930-508 for the following discussion.

A.5.1 SM-101 Synthesizer Module Interface

The Synthesizer module used is the Syntest SM-101. This is a single PC card with connections made by a 44 pin edge connector mounted on the Synthesizer Interface board. In addition to providing a convenient way to physically interface to the transmitter, there are other circuits that require some electrical interface from the transmitter to the Syntest module.

A.5.2 Frequency\Range Selection Circuits

The method to select frequency of the Synthesizer is by a 4 bit binary code for each digit. In order to allow the front panel Frequency Select switches to display the frequency always in kHz, a shift of the input BCD codes is required into the Synthesizer module.

A BCD To Binary Converter and Band Switch Logic in conjunction with the Digit Shift Circuits are used to encode the (4) 4-Bit BCD inputs from the Frequency Select switches such that the proper (4) 4-Bit Binary code is provided to the Synthesizer.

The Frequency Fault Detector's function is to read the BCD program switch information and to produce a Synthesizer Fault if the selected frequency is out of the 525 to 1605 kHz range of the transmitter.

NOTE - All of the circuits described above are contained within the SYNTH PAL and three Tri-State Digit Shift Buffers.

The frequency program data is latched by the Frequency Data Latch before going into the synthesizer to prevent inadvertent changing of frequency.

When the transmitter is operated below 1600 kHz, the 100 Hz Step Adjustment allows fine XXXX.1 to XXXX.9 kHz frequency selection.

A.5.3 Synthesizer Output Circuits

The output of the Synthesizer module goes through the Sync Switch, which will normally pass the output directly to the RF Driver and on to the RF Interface Board.

The RF Output Detector monitors the output signal and will generate a fault if there is no output. The Frequency Monitor Output is used as a frequency measuring test point and can also be used as a oscilloscope sync for other measurements.

Input and output connections as well as selection jumpers are also provided if an External RF Input is used in place of the synthesizer and\or the transmitter is in a combined mode.

A.5.4 Synthesizer Sync Circuits

During VSWR fault conditions, the VSWR Switch Input will activate the Synthesizer Sync Switch Control and the Synthesizer Interface output is connected to a phase compensated RF sample from the output network.

Proper phasing of the Combiner Current Sample to the Synthesizer output signal is performed using the Synthesizer Sync Data Input, a 6 bit binary code from the Frequency Control Interface board. The Synthesizer Sync Circuit uses a programmable digital delay line in the Digital Phase Adjustment. Band Indicators are provided as a visual indication of 6 bit binary code. The Most Significant Bit is used to switch between the Q and Q Not outputs for 180 degrees of phase shift.

The Synthesizer Sync Detector circuit produces a DC voltage relative to the difference in phase of the Synthesizer output and the Synthesizer Sync circuit output. This voltage can be measured on the TUNE Multimeter and is used as a reference voltage only.

WARNING: Disconnect primary power prior to servicing.

A.5.5 Power Supplies

+22VDC is regulated down to +15VDC and +9VDC, and +8VDC is regulated to +5VDC for on board circuits.

A.5.6 Synthesizer SYNC Circuit

The function of this circuit is to synchronize the Synthesizer Interface board RF output with an RF combiner current sample during any VSWR fault condition. This RF SYNC switching is controlled by the VSWR logic circuits on the Output Monitor board.

A.6 Detailed Circuit Description

Refer to the schematic diagram for the Synthesizer Interface board (839-7930-508) for all descriptions in this section.

A.6.1 SM-101 Synthesizer Module Interface

The Syntest SM-101 module is mounted underneath the Synthesizer Interface by a 44 pin edge connector, J8. The hinged rear standoffs allow access to the module when the front screws are removed. The following lists the inputs and outputs that are part of the interface connector.

A.6.1.1 Binary Frequency Inputs

The Synthesizer module requires 4-4 Bit Binary inputs to control the output frequency. Each of the 4 groups of 4 Bits ranges from the MSB Most Significant Bit Group to the LSB Least Significant Bit Group. Each individual group of 4 Bits has a binary value of 1, 2, 4, or 8. All 16 inputs are Latched by U9 and U10 prior to entering the module, the following list demonstrates the structure of the inputs from MSB Group to LSB Group.

NOTE - The inputs to the Synthesizer module are referred to as MSB, Most Significant Binary.

MSB 1
MSB 2
MSB 4
MSB 8
2MSB 1
2MSB 2
2MSB 4
2MSB 8
3MSB 1
3MSB 2
3MSB 4
3MSB 8
LSB 1
LSB 2
LSB 4
LSB 8

A.6.1.2 Range 1 Input

When the Synthesizer is selected to operate in the Low Band, from 525 to 1599 kHz, the Range 1 input must be a logic low. When the Synthesizer is selected to operate in the High Band, from 1600 to 1605 kHz, the Range 1 input must be a logic high. The Range 1 input is controlled by the SYNTH FAULT/BAND LOGIC PAL, U11.

A.6.1.3 Power Supply Inputs

+22VDC and +8VDC are used by the Synthesizer module to power its own internal circuits.

A.6.1.4 Other Interface Inputs

+5VDC is connected to the Range 2 and 4 inputs in addition to the Enable RF Output.

A.6.1.5 RF Output

The RF Output from the Synthesizer is a 5Vp-p squarewave at the selected carrier frequency and is connected to the Synthesizer Interface at J8-42.

A.6.2 Frequency\Range Selection

The function of the SYNTH PAL and the Tri-State Digit Shift Buffers is to take the 4-4 Bit BCD Frequency Select program switch information from the Frequency Control Panel and convert it to the appropriate 4-4 Bit Binary input to the Synthesizer.

For frequencies from 525 kHz to 1599 kHz, the Synthesizer is to operate on the Low Band which covers the range of 100 kHz to 1599 kHz. In this Band, the Most Significant Bit MSB on the input of the Synthesizer accepts numbers from 1-15.

When 1600 kHz and above is required, the Synthesizer must switch to the High Band to accept frequencies from 1.0 MHz to 15 MHz. In this Band, the Most Significant Bit MSB input of the Synthesizer is only required to be 1.

A.6.2.1 Frequency Select BCD Inputs

The Frequency Select BCD Inputs enter the board on J6. They are organized in a manner similar to the 4-4 Bit Binary inputs for the Synthesizer, except that they are Binary Coded Decimal. These 16 inputs are connected to the SYNTH PAL and the Tri-State Digit Shift Buffers. The following list demonstrates the structure of the inputs from MSB Group to LSB Group.

NOTE - The inputs to the Synthesizer Interface are referred to as MSD, Most Significant Digit.

MSD 1
MSD 2
MSD 4
MSD 8
2MSD 1
2MSD 2
2MSD 4
2MSD 8
3MSD 1
3MSD 2
3MSD 4
3MSD 8
LSD 1
LSD 2
LSD 4
LSD 8

WARNING: Disconnect primary power prior to servicing.

A.6.3 SYNTH PAL

The SYNTH PAL U11 has four main functions, Band Switch Logic, BCD to Binary Conversion, Digit Shifting, and Frequency Fault Detection.

Refer to Figure A-1 for the following discussion.

A.6.3.1 Band Switch Logic

The 3 Most Significant Groups of MSD inputs (MSD, 2MSD, and 3MSD) are connected to the Band Switch Logic. This circuit reads the BCD input codes and is basically used as decoder which produces the following outputs:

If a Low Band frequency has been selected:

a. The Band L output will be a logic low, enabling the Low Band buffers of U6, U2, and U1.

b. The Band H output will be a logic high, disabling the High Band Buffers of U6, U2, and U1.

c. The Range 1 output will be a logic low, allowing the Synthesizer to operate in the 525 to 1599 kHz frequency range, and this also disables the Digit Shifter.

If a High Band frequency has been selected:

a. The Band L output will be a logic high, disabling the Low Band buffers of U6, U2, and U1.

b. The Band H output will be a logic low, enabling the High Band Buffers of U6, U2, and U1.

c. The Range 1 output will be a logic high, allowing the Synthesizer to operate in the 1600 to 1605 kHz frequency range, and this also enables the Digit Shifter.

A.6.3.2 Frequency Fault Detector

The Frequency Fault Detector's function is to read the same BCD program switch information as the Band Switch Logic and to produce a Synthesizer Fault if the selected frequency is out of the 525 to 1605 kHz range of the transmitter. This fault will apply an RF Mute to the transmitter and illuminate the corresponding LED RED on the Frequency Control Panel.

A.6.3.3 BCD To Binary Converter And Digit Shift

The 2 Most Significant Groups of MSD inputs (MSD and 2MSD) are connected to the BCD To Binary Converter. This circuit reads the 2-4 Bit BCD input codes and converts them to the 4 Bit Binary MSB output to the Digit Shift.

The Digit Shift output to the Synthesizer is dependent upon the Range 1 output from the Band Switch Logic.

a. If the Range 1 output is a logic low (Low Band operation), the Digit Shift output will be the same output as from the BCD To Binary Converter. This output range is therefore from 1 to 15 depending upon the frequency selected.

b. If the Range 1 output is a logic high (High Band operation), the Digit Shift output will be 1 only.

A.6.4 Tri-State Digit Shift Buffers

The Tri-State Digit Shift Buffers U6, U2, and U1 are used to transfer the frequency selected BCD information to the appropriate Synthesizer Binary input depending on the band required. When the enable input on pin 1 is a logic low, the IC functions like a normal buffer. When the input is a logic high, all of the output pins are an open circuit.

A.6.4.1 Low Band Digit Shifting

When a Low Band frequency has been selected, the Band Low output of the SYNTH PAL U11-22 will be a logic low:

NOTE - All of the Low Band Buffers are active and all of the High Band Buffers are disconnected.

a. The MSD 4 Bit and 2MSD 4 Bit input are connected to the SYNTH PAL. The output of the Digit Shift inside the SYNTH PAL is directly connected to the MSB 4 Bit Synthesizer input.

b. The 3MSD 4 Bit input is connected to the 2MSB 4 Bit Synthesizer input via the Data Latch U9.

c. The LSD 4 Bit input is connected to the 3MSB 4 Bit Synthesizer input via the Data Latch U10.

d. The 100Hz Step Adjustment switch S1 is connected to the LSB 4 Bit Synthesizer input via the Data Latch U10.

A.6.4.1.1 100Hz Step Adjustment

When in the Low Band, the 100 Hz Step Adjustment switch S1 supplies the LSB 4 Bit input to the Synthesizer. This is a manual adjustment switch that is not part of the Frequency Select switches, and allows fine XXXX.1 to XXXX.9 kHz frequency selection.

Refer to Figure A-2, Band Switching Logic, for the following discussion.

If a frequency of 0525 kHz (upper left corner) was entered on the Frequency Control Panel Frequency Select switches:

a. The logic level of the BCD inputs is listed on the left side of chart.

b. The logic level of the Binary inputs to the Synthesizer is listed on the right side of the chart.

NOTE - In Low Band operation, the Decimal Point follows the 3MSB so the Binary input is 525.0 (100Hz Step Adjustment = 0)

If a frequency of 1599 kHz (upper right corner) was entered on the Frequency Control Panel Frequency Select switches:

a. The logic level of the BCD inputs is listed on the left side of chart.

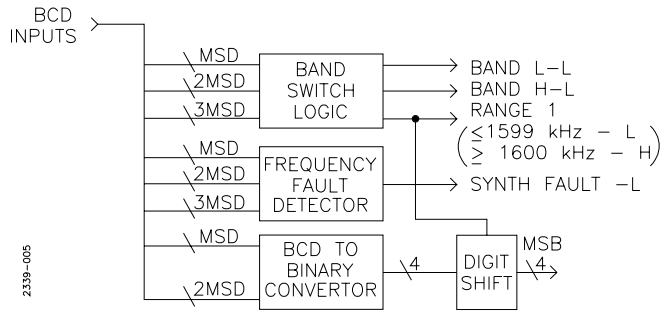


Figure A-1

WARNING: Disconnect primary power prior to servicing.

BAND SWITCHING LOGIC

525 kHz (BAND L)

BCD INPUT FROM PANEL SWITCHES		BINARY OUTPUT TO SYNTHESIZER	
MSD 1	[0] 0	MSB 1	[5] 1
2	0	2	0
4	0	4	1
8	0	8	0
2MSD 1	[5] 1	2MSB 1	[2] 0
2	0	2	1
4	1	4	0
8	0	8	0
3MSD 1	[2] 0	3MSB 1	[5] 1
2	1	2	0
4	0	4	1
8	0	8	0
			[•]
LSD 1	[5] 1	LSB 1	[0] [0]
2	0	2	[0]
4	1	4	[0]
8	0	8	[0]

1599 kHz (BAND L)

BCD INPUT FROM PANEL SWITCHES		BINARY OUTPUT TO SYNTHESIZER	
MSD 1	[1] 1	MSB 1	[15] 1
2	0	2	1
4	0	4	1
8	0	8	1
2MSD 1	[5] 1	2MSB 1	[9] 1
2	0	2	0
4	1	4	0
8	0	8	1
3MSD 1	[9] 1	3MSB 1	[9] 1
2	0	2	0
4	0	4	0
8	1	8	1
			[•]
LSD 1	[9] 1	LSB 1	[0] [0]
2	0	2	[0]
4	0	4	[0]
8	1	8	[0]

1600 kHz (BAND H)

BCD INPUT FROM PANEL SWITCHES		BINARY OUTPUT TO SYNTHESIZER	
MSD 1	[1] 1	MSB 1	[1] 1
2	0	2	0
4	0	4	0
8	0	8	0
			[•]
2MSD 1	[6] 0	2MSB 1	[6] 0
2	1	2	1
4	1	4	1
8	0	8	0
3MSD 1	[0] 0	3MSB 1	[0] 0
2	0	2	0
4	0	4	0
8	0	8	0
LSD 1	[0] 0	LSB 1	[0] 0
2	0	2	0
4	0	4	0
8	0	8	0

1605 kHz (BAND H)

BCD INPUT FROM PANEL SWITCHES		BINARY OUTPUT TO SYNTHESIZER	
MSD 1	[1] 1	MSB 1	[1] 1
2	0	2	0
4	0	4	0
8	0	8	0
			[•]
2MSD 1	[6] 0	2MSB 1	[6] 0
2	1	2	1
4	1	4	1
8	0	8	0
3MSD 1	[0] 0	3MSB 1	[0] 0
2	0	2	0
4	0	4	0
8	0	8	0
LSD 1	[5] 1	LSB 1	[5] 1
2	0	2	0
4	1	4	1
8	0	8	0

2339-006

1 = HIGH (+5VDC)
0 = LOW (0VDC)

[100Hz STEP ADJUSTMENT = 0]

Figure A-2

WARNING: Disconnect primary power prior to servicing.

b. The logic level of the Binary inputs to the Synthesizer is listed on the right side of the chart.

NOTE - In Low Band operation, the Decimal Point follows the 3MSB so the Binary input is 1599.0 (100Hz Step Adjustment = 0)

A.6.4.2 High Band Digit Shifting

When a High Band frequency has been selected, the Band High output of the SYNTH PAL U11-21 will be a logic low:

NOTE - All of the High Band Buffers are active and all of the Low Band Buffers are disconnected.

a. The MSD 4 Bit and 2MSD 4 Bit input is connected to the SYNTH PAL. The output of the Digit Shift inside the SYNTH PAL is directly connected to the MSB 4 Bit Synthesizer input.
b. The 2MSD 4 Bit input is connected to the 2MSB 4 Bit Synthesizer input via the Data Latch U9.
c. The 3MSD 4 Bit input is connected to the 3MSB 4 Bit Synthesizer input via the Data Latch U10.
d. The LSD 4 Bit input is connected to the LSB 4 Bit Synthesizer input via the Data Latch U10.

If a frequency of 1600 kHz (lower left corner) was entered on the Frequency Control Panel Frequency Select switches:

a. The logic level of the BCD inputs is listed on the left side of chart.
b. The logic level of the Binary inputs to the Synthesizer is listed on the right side of the chart.

NOTE - In High Band operation, the Decimal Point follows the MSB so the Binary input is 1.600 (100Hz Step Adjustment not active)

If a frequency of 1605 kHz (lower right corner) was entered on the Frequency Control Panel Frequency Select switches:

a. The logic level of the BCD inputs is listed on the left side of chart.
b. The logic level of the Binary inputs to the Synthesizer is listed on the right side of the chart.

NOTE - In High Band operation, the Decimal Point follows the 3MSB so the Binary input is 1.605 (100Hz Step Adjustment not active)

A.6.5 Data Latches

The frequency program data is latched by the Frequency Data Latches U9 and U10, before going into the Synthesizer to prevent inadvertent changing of frequency. No change in frequency can occur unless the Band Latch Input is clocked high. This clock input at J6-17, is a 4 kHz clock from the Frequency Control Interface board when the transmitter is in the FREQUENCY CHANGE MODE ONLY.

A.6.6 Synthesizer RF Output Buffer/Driver

The output of the Synthesizer, a squarewave at J8-42, is inverted by buffer U5-7. This signal will normally pass through JP2 1-2, JP1 2-1, and the normally closed contacts of U4 4-2 and is applied to U3-2. The output impedance of inverter U3-7 is very low, and resistor R31 sets the 50-Ohm output impedance of the Synthesizer Interface board. The output signal at J4-8 is a 4-4.5 Vp-p square wave and connects to the RF Interface.

A.6.7 Synthesizer Detector Output

The RF output from U3-7 is converted to positive and negative dc voltages by peak detectors CR7-C18 and CR6-C17. These dc voltages go to a fault circuits on RF Interface, through resistors R19 and R21. With a normal squarewave output, the (+) voltage is greater that the (-) voltage output. If the RF output from the Synthesizer Interface board is a continuous logic high or logic low, the (-) will become greater that the (+) and a Synthesizer Fault will be generated on the RF Interface.

A.6.8 External Input

An AM stereo generator or high-stability external oscillator can be connected to BNC jack J2, which is located on the Synthesizer Interface board. The external input impedance is either 50 Ohms or approximately 20k Ohms, depending on the position of jumper plug P3. The high impedance input is for use with TTL level (4 to 4.5 Volt peak-to-peak square wave). With a 50 Ohm input impedance, RF input levels from 0 to +25 dBm can be accommodated. (At 50 Ohms, 0 to +25 dBm is 1 mW to 316 mW, or 0.22 V rms to 4 V rms).

Amplifier Q3 and buffer/driver U5-5 provide a logic-level signal to JP2 3. Diodes CR8 and CR9 at Q3 input provide protection against excessive input voltages.

A.6.9 Internal/External Synthesizer and Combined Transmitter Operation

Jumper plug JP1 is used to select either the internal Synthesizer or an external combiner RF Input. JP1 2-1 selects the internal Synthesizer while JP1 2-3 disconnects the internal Synthesizer and passes the external input to U4-4.

NOTE - If the transmitter is operated in a combined mode, refer to the combiner Technical Manual for more information on the RF drive system.

A.6.10 Frequency Monitor Output

Inverter U3-5 provides an output signal to a frequency monitor or counter. Resistor R17 sets the output impedance at 50 Ohms. The frequency monitor output signal, at BNC connector J5, will be a 4-4.5 Volt peak-to-peak square wave at the transmitter operating frequency when the load impedance is 50 Ohms. This RF signal can be used as an oscilloscope external RF sync signal when making other RF measurements.

A.6.11 Synthesizer SYNC Circuit

The function of this circuit is to synchronize the Synthesizer Interface board RF output with a RF combiner current sample during any VSWR fault condition. This RF SYNC switching is controlled by the VSWR logic circuits on the Output Monitor board.

A.6.11.1 Combiner Current Sample

The combiner output current sample from T4, is brought to the Synthesizer Interface board at J3-1. R37 provides a 100-Ohm input impedance.

WARNING: Disconnect primary power prior to servicing.

A.6.12 Phase Adjustment

After the RF is phase lead shifted, the RF is clamped to TTL levels by the diodes CR5 and CR10. The RF squarewave is inverted by U13-4 and connected to U18-6.

A.6.12.1 Digital Phase Adjustment

U18 is a programmable digital delay line that will change the phase lag delay of a TTL input signal in discreet nS steps depending on the Bit 0 through Bit 5 inputs.

The MSB Bit 5 is used to select which output of the Digital Phase Adjustment is used. This allows 180 degrees of phase shift required by certain frequencies.

A.6.12.2 Synthesizer SYNC Data Input

The Bit 0 (LSB) through Bit 5 (MSB) enters the board on J6-1 through J6-11 (all odd numbered pins). All Bit 0 - 4 inputs are applied to U18, and Bit 5 is connected to MOSFET switch Q1 for driving K1.

A.6.12.3 Band Indicators

A 10 segment Band Indicator LED is used to give a visual indication of the Synthesizer SYNC Data Input. If the Bit input is a logic high, inverter U12 applies a logic low to the cathode of the appropriate LED, illuminating the indicator RED.

A.6.12.4 Synthesizer SYNC Switch

Integrated Circuit U4 is a CMOS analog switch, which selects one of two RF signals. During normal operation, the Synthesizer RF output from JP1 and is connected through U4 to inverter U3 and on the RF Interface board.

During a VSWR fault, the VSWR-H input at J7-5 goes logic high and saturates Q5. U4-6 is then grounded and U4 switches so that the Synthesizer SYNC RF sample is used as the transmitter's RF drive.

A.6.12.5 Synthesizer SYNC Detector

In order to have a single indicator of Synthesizer SYNC, a detector is used which will produce an output voltage relative to the difference in phase between the Synthesizer RF output signal and the Synthesizer SYNC signal output from the phase adjustment circuitry. U8 is a PLL Phase Locked Loop detector that is triggered on the input risetime of Synthesizer RF output and the Synthesizer SYNC signal.

This makes the phase detector only indicate errors due to phase difference and not duty cycle changes which can occur on the Synthesizer Sync circuit especially at lower power levels.

If the two inputs are both high or low the output will be 0. If the two inputs are different a 5 VDC output pulse occurs for as long as the two signals are out of phase. This series of pulses is integrated by the RC combination to produce a voltage output relative to the phase difference.

Buffer amplifiers U14-1 and U14-7 connect these outputs to a Differential amplifier formed by U14-8 and associated components. The Synthesizer SYNC Error output voltage at TP9 is connected to the Frequency Synthesizer Interface board at J6-15. This voltage is metered on the TUNE Multimeter, which is controlled by the Frequency Control board.

Inverters U13-6 and U13-8 along with C30 and Q4 form a power-up reset circuit for U8. Q4 will allow the +5VB supply to come up for U8 only after the Synthesizer SYNC signal is present.

A.6.13 Power Supplies

DC supply inputs to the Synthesizer Interface board are +22VDC, - 22VDC and +8VDC, from the low voltage power supply. Each input is fused, with 2 A fuses F1, F2 and F3, and regulated to +15VDC, -15VDC and +5VDC using regulators U16, U7,and U15. The +15VDC and +5VDC supplies have a green Status LED that lights when the regulator is operational. The output of these regulators are transient protected by tranzorbs CR3 and CR2.

The +15 VDC supply is connected to a shunt zener diode CR13 that forms the +9VDC supply.

A.7 Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Failure of the Synthesizer Interface will result in a FREQUENCY SYNTHESIZER FAULT and a LOW DRIVE FAULT

A.7.1 Measure The Power Supplies

a. Check the dc voltage at each side of F1, F2, and F3. All supplies should be present any time low voltage ac power is on provided the Low Voltage Power Supply is in the "NORMAL" mode. The Control Multimeter will indicate whether transmitter low voltage power supply voltages are present.

b. Check the voltages at TP8 +15VDC, TP1 +5VDC, TP3 +9VDC, and TP14 -15VDC. If one voltage is missing, a regulator may be shorted or there may be a short in a circuit supplied by that voltage.

A.7.2 Measure The VSWR-H Input

Observe the voltage at J7-5, if this voltage is more than about +1 Volts when the transmitter if off, there is probably a fault on the Output Monitor board. (When VSWR faults are detected, logic high pulses will appear at J7-5.).

A.7.3 Measure The RF Output Signal

Using an oscilloscope and frequency counter, check for RF output at J8-42 (a convenient place to check this is past the inverter at JP2-1). A square wave of 4-4.5 Volts peak-to-peak at the transmitter carrier frequency should be present.

A.7.3.1 No RF Signal Present

a. Check that the proper voltages are present on the Synthesizer module interface connector J8.

b. Check the logic levels of the MSB input signals into the Synthesizer module. Changing the frequency to a value shown in Figure A-2 and using the levels in the chart may be useful.

WARNING: Disconnect primary power prior to servicing.

1. If the above checks appear correct, replace the Synthesizer module.

A.7.3.2 RF Signal Present

If an RF signal is present, sequentially check the following test points.

a. TP5 SYNTH RF
   1. If no RF signal is present, check jumpers JP1 and JP2 along with inverter U5-7.

b. J4-8 Synthesizer RF Output
   1. If no RF signal is present, check switch U14 and inverter U3-7.
   2. If an RF signal is present, measure and troubleshoot the RF Output Detector voltages.

A.7.3.3 RF Signal Wrong Frequency

a. Make sure that the Frequency Change mode has been selected.

b. Check that the proper voltages are present on the Synthesizer module interface connector J8.

c. Check the logic levels of the MSB input signals into the Synthesizer module. Changing the frequency to a value shown in Figure A-2 and using the levels in the chart may be useful.
   1. If the above checks appear correct, replace the Synthesizer module.

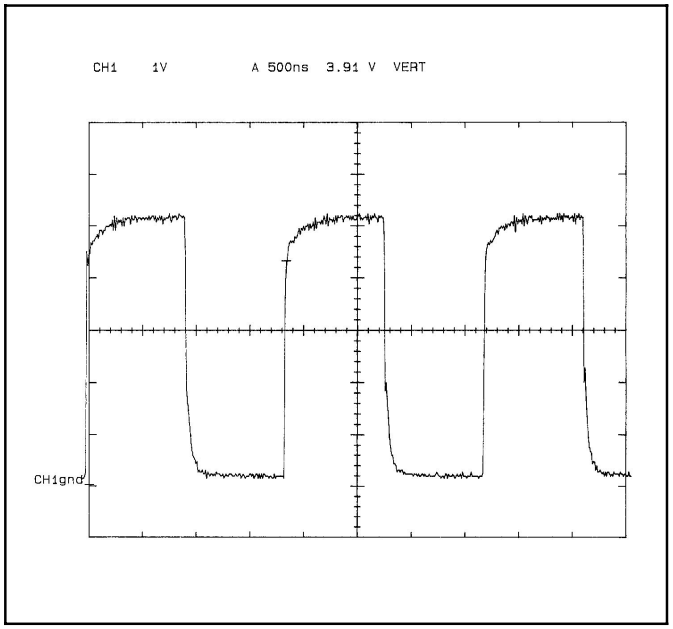
A.8 Removal\Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting screws.

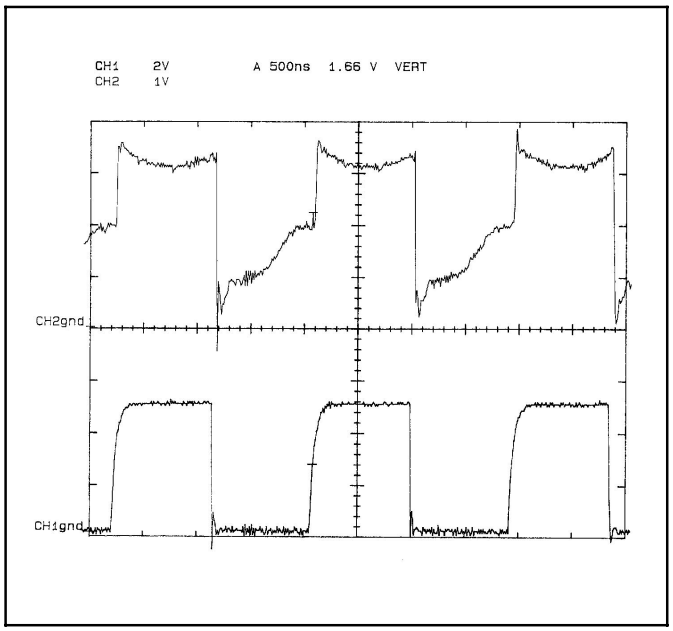
When installing a new board, verify that all jumpers on the new board are in the same position as the corresponding jumpers on the original board.

A.9 Alignment

There are no alignments on this board.



JP2-1



Upper Trace CH2 TP5
Lower Trace CH1 TP4

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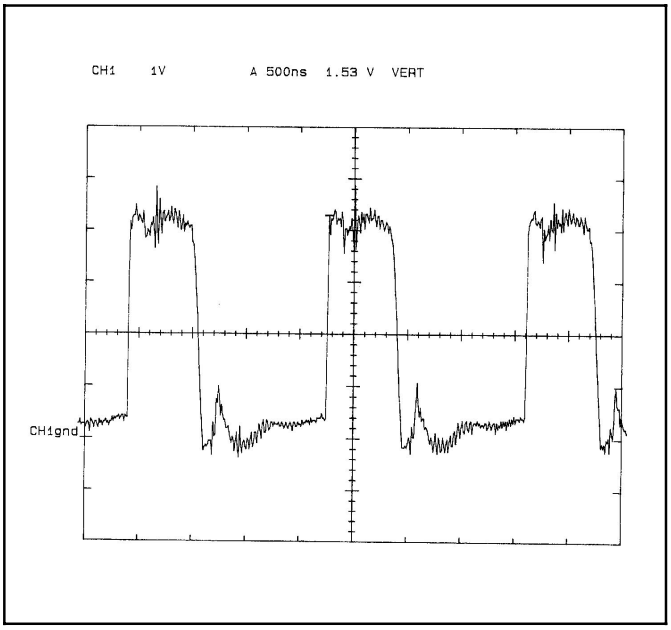
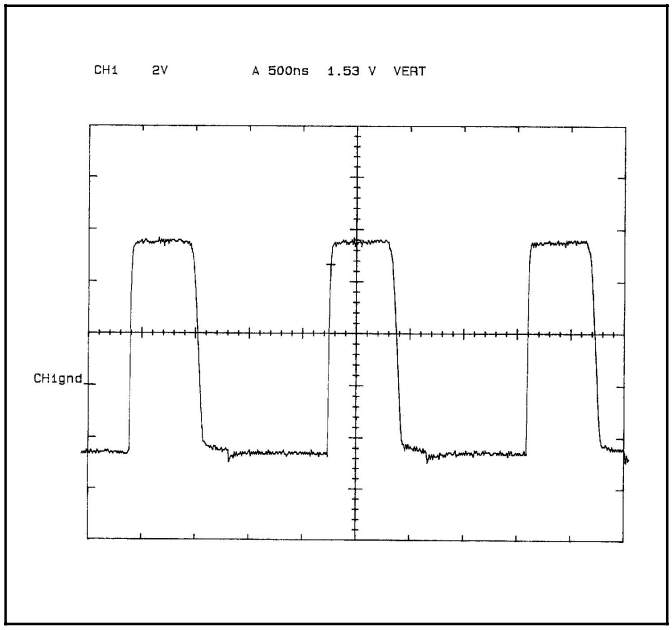
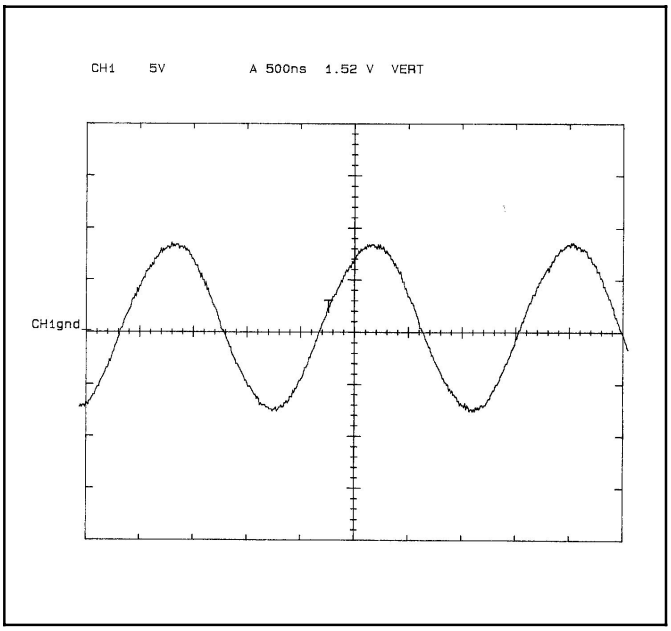


J4-8



J5-1



J3-1

WARNING: Disconnect primary power prior to servicing.

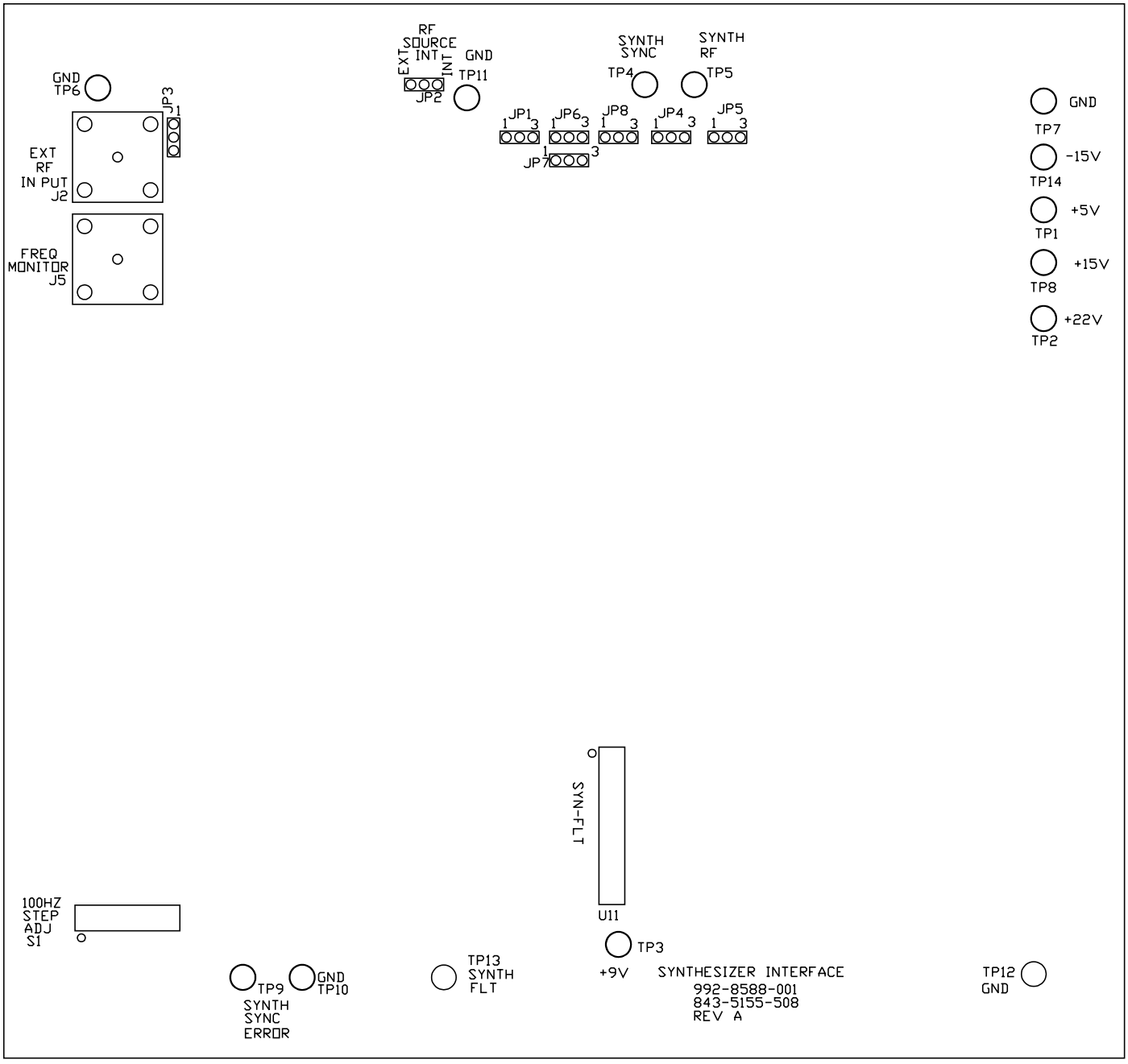


Figure A-3. Synthesizer Interface Board Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

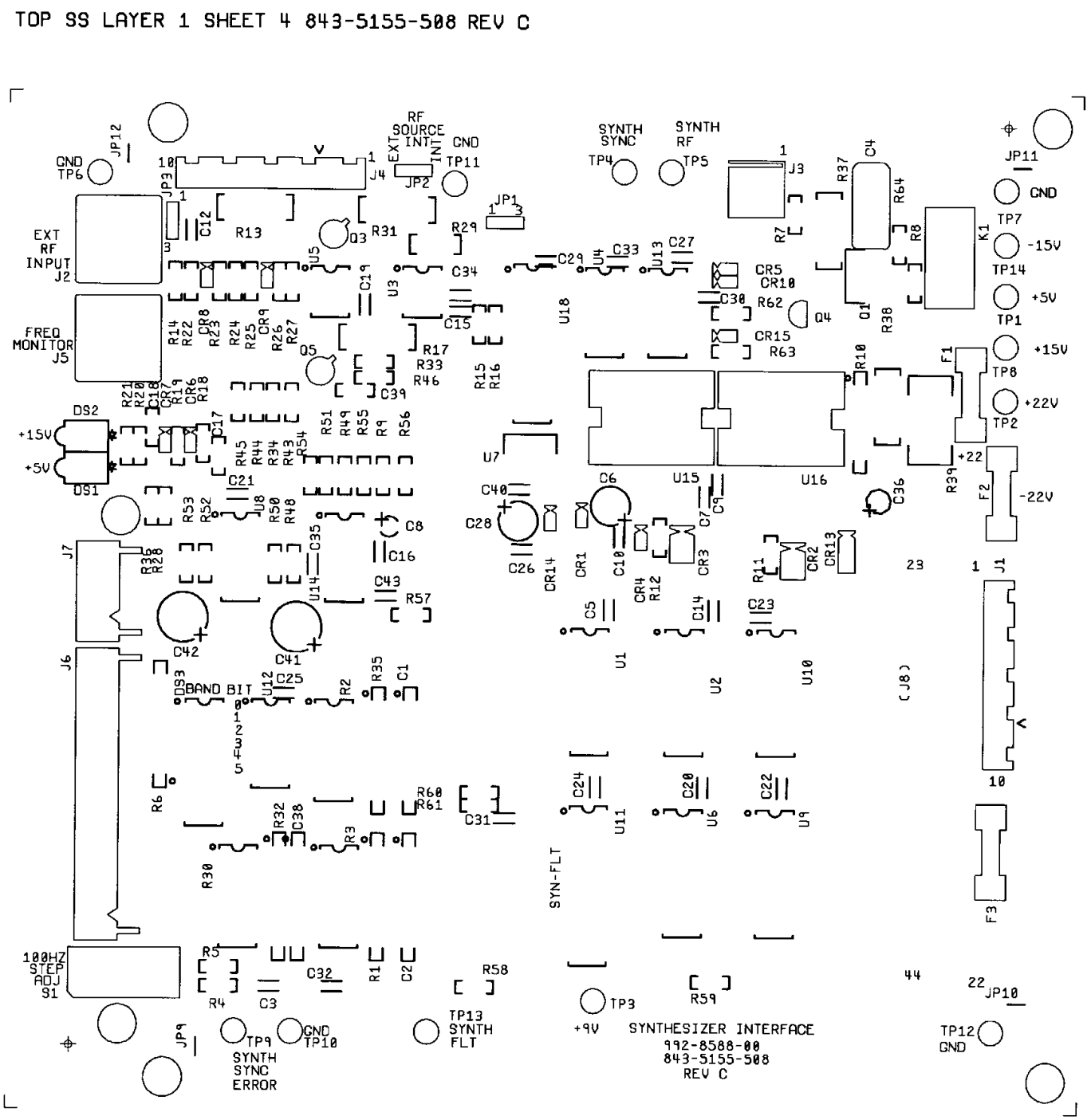


Figure A-4. Synthesizer Interface Board
Component Locator

WARNING: Disconnect primary power prior to servicing.

B.1 Introduction

This section covers the RF Interface board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal\replacement.

NOTE: Parts List for this board is covered in Section VII.

B.2 Function

The RF Interface board contains circuits for selecting Synthesizer Interface A or optional Synthesizer Interface, combined transmitter RF switching and interfacing, and active Frequency Synthesizer fault sensing. The RF output of this board goes to the Buffer Amplifier via the Driver Combiner Motherboard.

B.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100 kW with no modulation at 540 kHz carrier frequency.

B.4 Location

The RF Interface board is located in the right front compartment on the upper left side. (SEE VIEW 10)

B.5 Block Diagram Description

Refer to Figure B-1, RF Interface Block Diagram, for the following discussion.

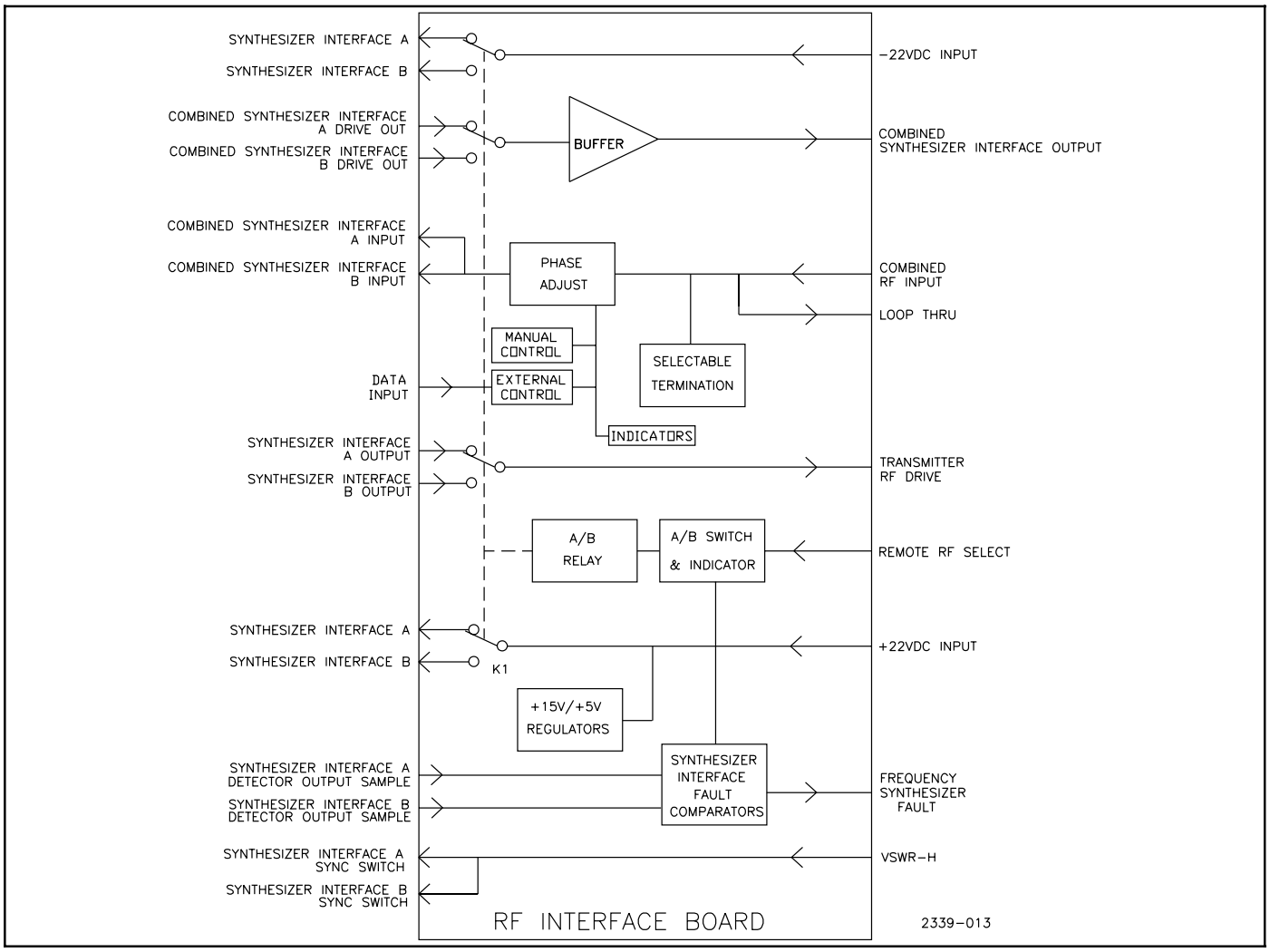


Figure B-1. RF Interface Block Diagram

Warning: Disconnect primary power prior to servicing.

B.5.1 Synthesizer Interface Switching

Normally, Synthesizer Interface A is selected for operation and a relay on the RF Interface supplies Sythesizer Interface A with +22VDC and +8VDC in addition to selecting the Sythesizer Interface A RF output. Optional Synthesizer Interface B, if installed, can be selected by switching the relay to the opposite position.

B.5.2 Fault Sensing

Fault sensing for the active Synthesizer Interface is accomplished by applying the Synthesizer Detector Output to a comparator. If the Synthesizer Interface output is not present, the comparator sends a Synthesizer Fault to the Controller board.

The inactive Synthesizer Interface comparator is inhibited from causing a Synthesizer Fault.

B.5.3 Power Supplies

+22VDC is regulated down to +15VDC and +5VDC to power circuits on the board.

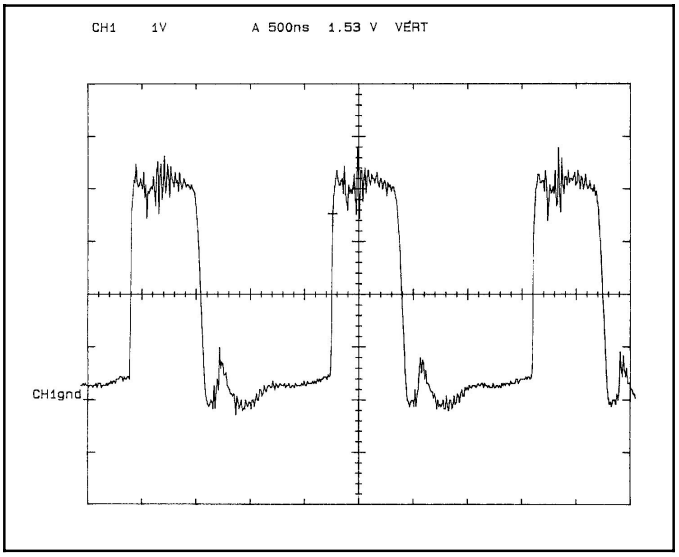
B.5.4 Combined Transmitter RF Switching

Several circuits on the board are reserved for combined transmitter applications and are not used in a single system transmitter. Refer to the combiner technical manual for information regarding the use and function of these circuits.

B.6 Detailed Circuit Description

Refer to the schematic diagram for the RF Interface board (839-7930-515) for all descriptions in this section.

NOTE - Any part of the schematic that is contained within dashed lines is not being used in this application and therefore the parts are not installed.



TP5

B.6.1 Power Supply Switching

Relay K1 and Synthesizer Select switch S2 are shown in the normal Synthesizer Interface A selected position. +22VDC and +8VDC are connected to Synthesizer Interface A at J2 by K1 contacts 12 and 4 and K1 contacts 11 and 3 respectively. Indicator DS3, Syntheiszer Interface A Selected, is connected to the +22VDC supply and will be illuminated GREEN.

When K1 is energized, the supplies are connected to optional Synthesizer Interface B at J9 and DS4, Synthesizer Interface B Selected, will illuminate.

Crystal Heater Select jumpers P1 and P2 are normally jumpered 2-3, they are disconnected when an RF Interface board is used with a Synthesizer that does not require crystal heaters.

B.6.2 RF Interface Output Switching

B.6.2.1 Synthesizer Interface A Selected

Transmitter Drive Out (from Synthesizer Interface board A) enters at J3-1 and passes through the K1 contacts 2 and 10 to TP5 RF Out and J7-1. Transmitter RF Drive at J7-1 then connects to the Driver Combiner Motherboard and eventually to the Buffer Amplifier.

B.6.2.2 Synthesizer Interface B Selected

If selected, Transmitter Drive Out (from Synthesizer Interface B), enters at J8-1 and passes through the K1 contacts 6 and 9 to TP5 and J7-1.

B.6.2.3 Relay Supply

Zener diodes CR1 and CR6 are connected to the +22VDC, and are in series with the relay coil. This drops the +22VDC to +12VDC for the relay coil at pin 13. If the Synthesizer Select switch, S1, is in the B position, a ground is applied to the relay coil at pin 14 and the relay energizes. Likewise, a remote/extended control input will deliver Remote RF Select-H logic high to J11-7 that turns Q1 fully on and also applies a ground to K1.

B.6.3 Fault Sensing Comparators

B.6.3.1 Synthesizer Interface A

Normally, when Synthesizer Interface A is selected, the RF(-) input at J12-3 is -.6VDC and RF(+) input at J12-1 is +3.5VDC, and comparator U2-2 output at TP11 is a logic high.

Should Synthesizer Interface A fail, the RF(-) voltage will be greater than the RF(+) voltage and TP11 will go to a logic low.

The voltage at U2-9 will be 2.6VDC, established by a resistor divider, R8 and R10.

B.6.3.2 Synthesizer Interface B

When Synthesizer Interface B is selected, the same voltages are supplied to J10-3 and J10-1, and the output of U2-1 at TP12 is a logic high. If a failure occurs, the voltage at U2-11 will be 2.6VDC.

B.6.4 Fault Sensing Selection

B.6.4.1 Synthesizer Interface A Selected

K1 is de-energized and approximately +10VDC is supplied to U2-8 through the relay coil. Normally U2-9 is +15VDC and the output of U2-14 at TP6 Synthesizer Fault is logic high.

Warning: Disconnect primary power prior to servicing.

When TP11 goes low and U2-9 goes to +2.6VDC, the output of U2-14 goes LOW and TP6 is a logic low. A Synthesizer Fault-L is generated and sent to the Controller via the Transmitter Interface.

Diode CR8 pulls up U2-11 to the +10VDC supply, so a fault can not be generated by U2-13 (Synthesizer Interface B Fault).

B.6.4.2 Synthesizer Interface B Selected

K1 is energized and 0VDC is applied to U2-8 to prevent U2-14 (Synthesizer Interface A Fault) from going logic low. Diode CR8 is reversed biased, and the voltage at U2-10 is set at +4.6VDC by R13 and R8. Should Synthesizer Interface B fail, U2-11 goes to +2.6VDC and U2-13 goes to a logic low, generating a Synthesizer Fault-L to the Controller via the Transmitter Interface.

B.6.5 VSWR Control Line

If the Output Monitor generates a VSWR-H signal, a logic high appears at J11-5 and TP16 for 250nS. This voltage is distributed to Synthesizer Interface A at J12-5 and optional Synthesizer Interface B at J10-5 for SYNC switching.

B.6.6 Power Supplies

+22VDC passes through F1 and is regulated down to +15VDC by U4. U3 is connected to the +15VDC and forms a +5VDC supply. Indicators DS2 and DS1 illuminate GREEN when the respective supplies are operational.

B.7 RF Interface Troubleshooting

Problems on this board can be classified into three areas. These are:

a. Power Supply
b. Signal Switching, and
c. Fault Sensing.

Refer to the RF Interface Schematic (839-7930-515) as needed for this section. Troubleshooting the circuitry associated with the combined transmitter mode is covered in the combined transmitter manual.

B.7.1 Power Supply

Begin troubleshooting by:

a. Checking that the +15VDC (DS2) and +5VDC (DS1) LED's are lit with the low voltage on only.
b. If DS1 is out but DS2 is lit:
   1. Check TP1 for +5VDC.
   2. If not present, check U3, and associated circuitry.
c. If both indicators are out:
   1. Check F1, and replace if open.
   2. If F1 is not open, then check for +22VDC on J1-1 and -22 VDC on J1-3.
   3. If not present, refer to the Transmitter Troubleshooting section to troubleshoot the Low Voltage Supply.
   4. If +22VDC is present, check TP2 for +15VDC.
   5. If not present, check U4 and associated circuitry.

After repairs are made to the Power Supply, check the output of the supplies to ground with an ohmmeter for shorts before applying power to the board.

B.7.2 Signal Switching

If the transmitter will not switch between Synthesizer Interface A and Synthesizer Interface B and/or there is no signal at TP5 (RF Out), the Synthesizer Interface Select Circuit may have failed.

Note

If remotely switched to Synthesizer Interface B, local control will have no effect.

a. Toggle the Synthesizer Select Switch (S2).
   1. The Synthesizer Selected indicator (DS3 or DS4) should light and extinguish as the switch is activated and relay K1 should change states.
   2. If no indicator lights and K1 does not change states, then check TP3 for +22VDC.
   3. If not present, refer to the Transmitter troubleshooting section for troubleshooting the Low Voltage Supplies.
b. If the indicators switch and K1 changes state but there is no signal at TP5, check for the presence of RF at the contacts of K1. Pins 2 and 6 are the input to the relay and pin 10 is the output.
   1. If there is no input check the connector associated with the selected Synthesizer Interface for a signal.
   2. If not present, refer to the Troubleshooting section of the Synthesizer Interface and/or check cable for an open or short.
c. If the input is present, but there is no output at pin 10, disconnect J7 on the board.
   1. If the signal returns, refer to the Troubleshooting section of the Driver Combiner Motherboard and/or check the cable for a short.
   2. If the signal is still not present, replace K1.
d. If DS3 indicator remains on and K1 does not change states when S2 is toggled, check the cathode of CR2 for +12VDC.
   1. If not present, check CR1, CR6 and F1.
   2. If the +12VDC is present, check for +8 Volt on the anode of CR2 when Synthesizer Interface A is selected and 0VDC when Synthesizer Interface B is selected.
   3. If the voltage changes but no action is seen on K1 or the LED's fail to switch, replace K1.
   4. If voltage on the anode of CR2 does not change from +8 Volts, verify low resistance to ground when S2 is in the B position.
   5. If no change is seen in resistance, replace S2.
e. If DS4 is lit and the voltage at the anode of CR2 remains at 0VDC, verify that the Remote RF Select line from the Transmitter Interface board is not active (High), to be sure

Warning: Disconnect primary power prior to servicing.

it is the local control causing K1 to activate not a remote control input.

1. If active, refer to the Transmitter Interface section of the manual.
2. If not active, check U1 and/or CR3.

B.7.3 Fault Sensing

Begin Troubleshooting as follows:

a. Check the state of TP6 (Synthesizer Fault).
   1. If this is logic high, the transmitter should not display a fault on the front panel.
   2. If a fault is displayed, refer to the Controller section of the manual for further troubleshooting.

b. If this line is a logic low, select Sythesizer B (if equipped) with S2.
   1. Verify that DS4 lights indicating that Synthesizer B is selected.
   2. If not, refer to Signal Switching Section of this procedure.

c. After selecting Synthesizer Interface B, check TP6 for a logic high.
   1. If present, troubleshoot Synthesizer Interface A sensing circuit.
   2. If there is no change, troubleshoot Synthesizer Interface B sensing circuit.
   3. If the transmitter is not equipped with Synthesizer Interface B troubleshoot Synthesizer Interface A sensing.

B.7.4 Synthesizer Interface A Sensing

a. Check the voltage on TP11 for a logic high.
   1. If the high is present, unplug J12 and monitor TP11, the voltage should go to a logic low.
   2. If not, change U2.

b. If the high is not present on TP11, check the input to U2-4. It should be approximately -0.6VDC.
   1. Check the input to U2-5. It should be approximately +3.5VDC.
   2. If these are not correct, refer to Troubleshooting the Synthesizer Interface Detector Output sample lines. Also check the cabling for opens or shorts.

c. If the inputs to U2 are correct, replace U2.

d. If TP11 changes states when J12 is unplugged, check the inputs to U2-8 and U2-9.
   1. U2-8 should be approximately 2.6VDC and U2-9 should be the logic high presented at TP11.
   2. If U2-8 is greater than 2.6VDC check CR3 and U2.
   3. If U2-8 is zero or low check CR3, U2, R8, and U1.

B.7.5 Synthesizer Interface B Sensing

a. Check the voltage on TP12 for a logic high.
   1. If the high is present, unplug J10 and monitor TP12, the voltage should go to a logic low.
   2. If not, change U2 and/or check CR8.

b. If the high is not present on TP12, check the input to U2-6. It should be approximately -.6VDC.
   1. Check the input to U2-7 it should be approximately +3.5VDC.
   2. If these are not correct, refer to the Troubleshooting the Synthesizer Interface Detector Output sample lines. Also check the cabling for opens or shorts.

c. If the inputs to U2 are correct, replace U2.
   1. If TP12 changes states when J10 is unplugged, check the inputs at U2-10 and U2-11.
   2. U2-10 should be approximately 2.6VDC and U2-11 should be the high presented at TP12.
   3. If U2-10 is greater than 2.6VDC check the voltage divider (R13 and R8) and U2.
   4. If U2-10 is zero or low check, U2, C18, and R13.

B.8 Removal\Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting screws.

When installing a new board, verify that all jumpers on the new board are in the same position as the jumpers on the original board.

B.9 Alignment

There are no alignments on this board.

Warning: Disconnect primary power prior to servicing.

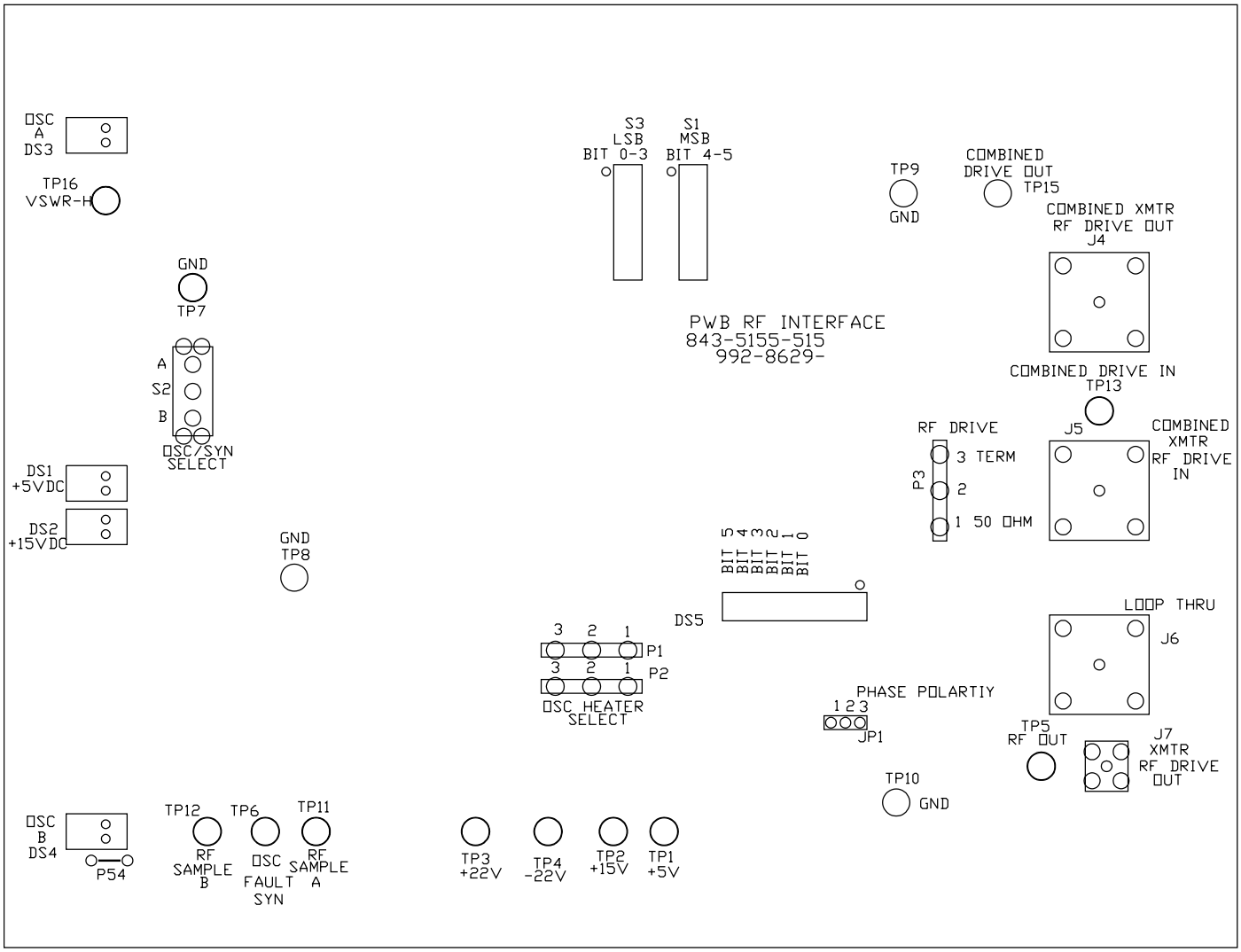


Figure B-2. RF Interface Controls and Indicators

Warning: Disconnect primary power prior to servicing.

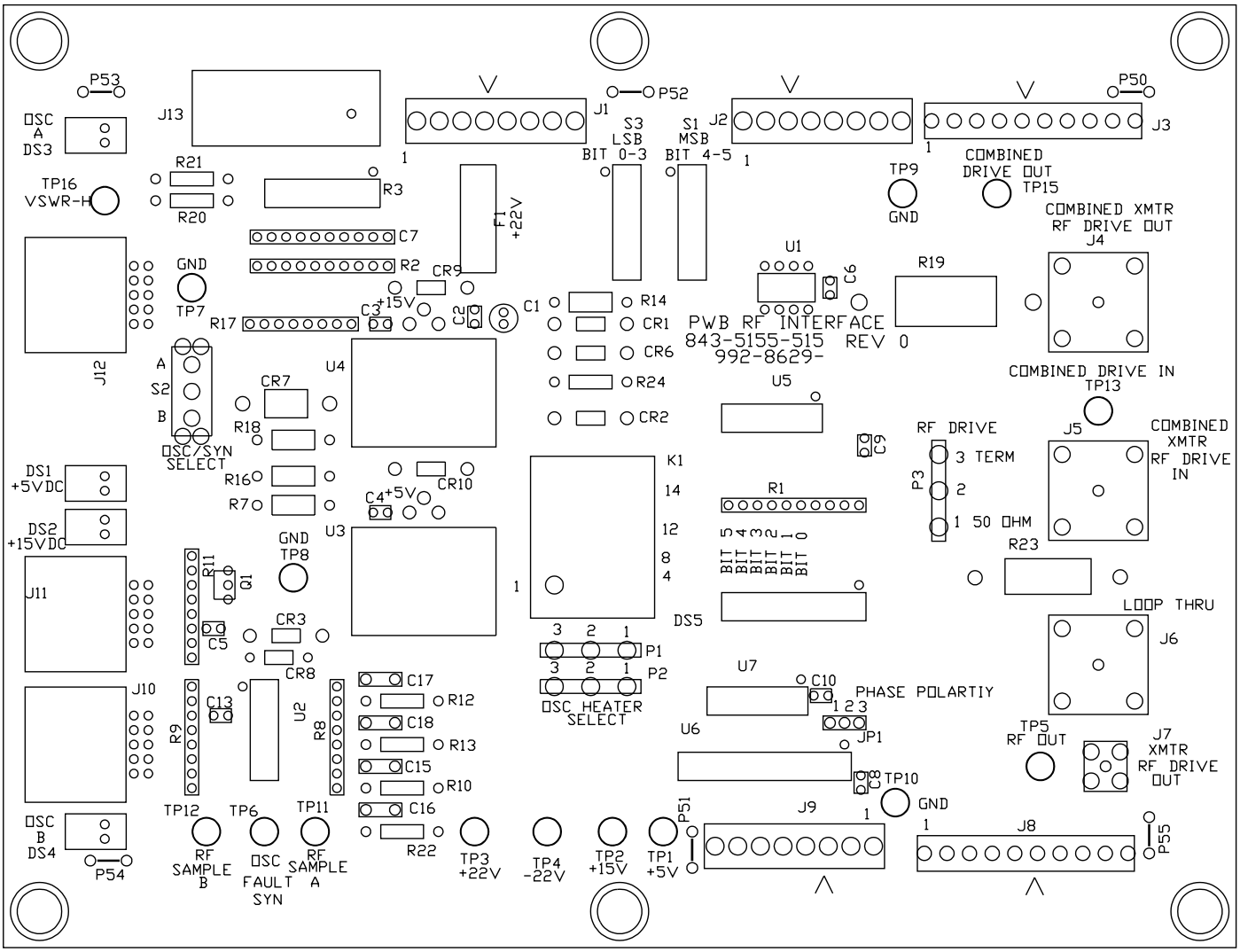


Figure B-3. RF Interface Component Locator

Warning: Disconnect primary power prior to servicing.

Section C
Driver Combiner Motherboard (A5)

C.1 Introduction

This section describes the Driver Combiner Motherboard. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

Following this section, the Buffer, Predriver, and RF Drivers will be discussed since they are boards that plug-in to the Driver Combiner Motherboard.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE: Parts List for this board is in Section VII.

C.2 Function

The purpose of the Driver Combiner Motherboard is to provide the input/output connections for the Buffer, Predriver, and 14 RF Driver amplifiers. Other functions include Predriver Switching, Buffer and Predriver RF Sense, and RF Driver Combining.

C.3 Location

The Driver Combiner Motherboard is located in the upper right PA compartment. (SEE VIEWS 10 & 15)

C.4 Detailed Circuit Description

Refer to Driver Combiner Motherboard Schematic Diagram (839-7930- 504), and Figure C-1 Driver Combiner Motherboard for the following discussion.

C.4.1 Buffer Amplifier Connections - J1

C.4.1.1 RF Input

The signal from the RF Interface board enters the Driver Combiner Motherboard at J30-1, and is routed directly to the Buffer Amplifier RF input at J1-15.

C.4.1.2 Power Supply

A +60VDC line from the RF Amp Power Supply passes through R37 & tapped resistor R2, and enters the Driver Combiner Motherboard at J32-3. It is connected to the Buffer Amplifier at J1-41, and can be varied from 20 to 45VDC by R2, Buffer Voltage Adjust.

C.4.1.3 RF Output

The Buffer Amplifier RF output for Section A enters the Driver Combiner Motherboard at J1-49 and is routed to J2-49.

The Buffer Amplifier RF output for Section B enters the Driver Combiner Motherboard at J1-53 and is routed to J2-53.

C.4.1.4 Buffer RF Sense

Peak detectors provide a Buffer Amplifier RF Sense signal for Section A and Section B outputs to fault and overload circuits on the Driver Encoder board.

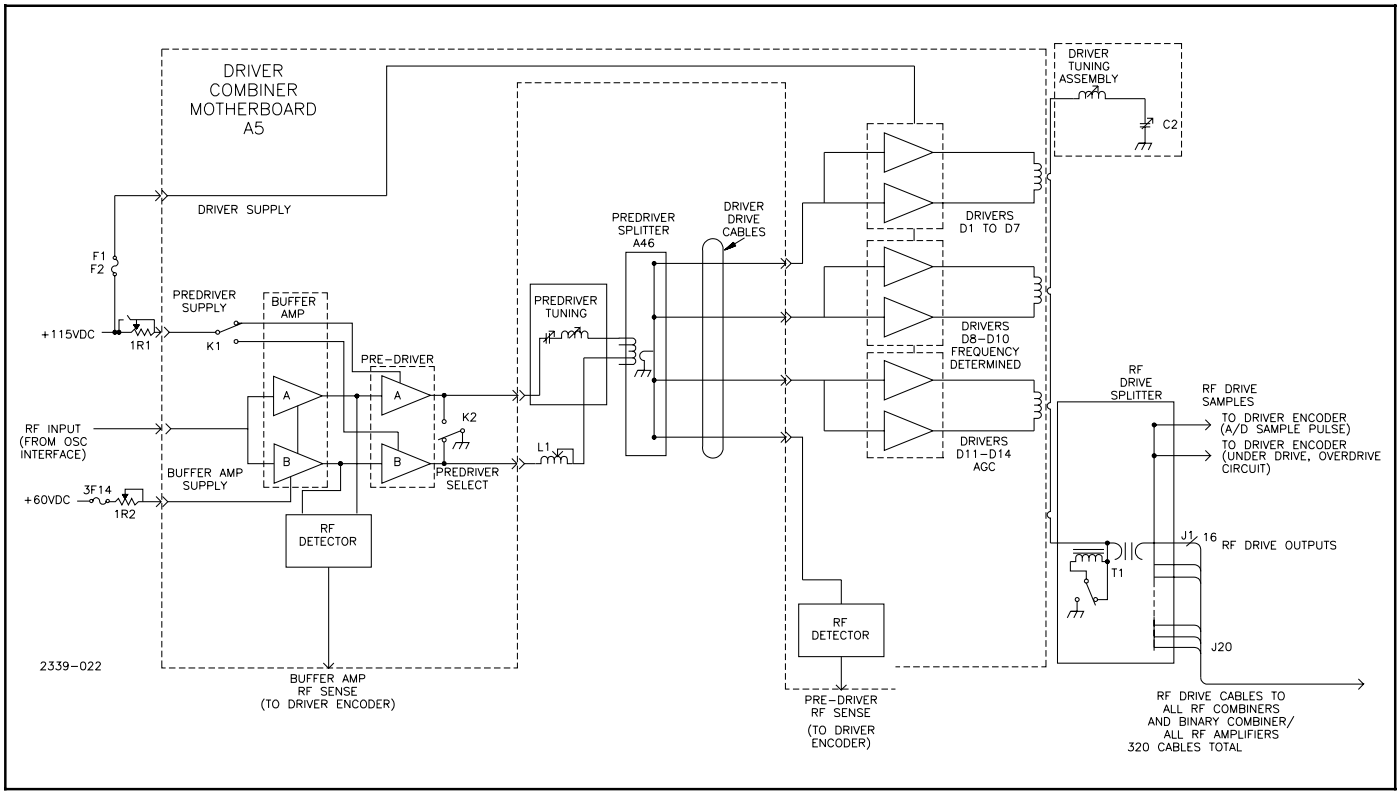


Figure C-1. Driver Combiner Motherboard

WARNING: Disconnect primary power prior to servicing.

The Section A goes to a peak detector formed by CR3 and C9. When RF is present, J31-13 will have a positive voltage approximately 1/2 the peak-to-peak waveform. Zener diode CR4 limits the detectors' maximum dc output voltage.

The Section B detector is formed by CR5/C8, connected to J31-11, and protected by CR6.

C.4.2 Predriver Connections - J2

C.4.2.1 RF Input

The RF output from Buffer Amplifier Section A enters the Predriver Section A RF Input at J2-49.

The RF output from Buffer Amplifier Section B enters the Predriver Section B RF Input at J2-53.

C.4.2.2 Power Supply

A +115VDC line from the RF Amp Power Supply passes through tapped resistor R1, and enters the Driver Combiner Motherboard at J32-1. It can be varied from 90 to 115VDC by R1, Predriver Voltage Adjust.

It passes through metering circuit resistor R20 and is connected to the common of K1.

C.4.2.3 Predriver Switching

Relays K1 and K2 are controlled by the Driver Encoder and select which Section of the Predriver is active. A Predriver Relay Supply of +15 VDC is supplied to both relays at J31-19.

C.4.2.3.1 Predriver A Selected

Normally Predriver Section A is selected, and the Predriver Relay Drive input at J31-17 is an open circuit. Both relays are in the de-energized state as drawn.

K1 switches the supply voltage to J1-1 which loops through the Predriver A fuse on the Buffer Amplifier and is sent to J2-23.

K2 grounds the inactive Predriver B output at J2-8.

Predriver A RF output at J33-1 is connected to Predriver Tuning board at J2 and returned through a series-tuned L1 to ground at J32-6.

C.4.2.3.2 Predriver B Selected

When Predriver Section B is selected, and the Predriver Relay Drive input at J31-17 is grounded. Both relays are energized and connected opposite as drawn.

K1 switches the supply voltage to J1-8 which loops through the Predriver B fuse on the Buffer Amplifier and is sent to J2-29.

K2 grounds the inactive Predriver A output at J2-2.

Predriver B RF output at J32-6 passes through L1 and to Predriver Tuning board TB1-7 and returns to ground at J33-1.

C.4.2.4 Predriver Metering

The voltage drop across R20 depends on the Predriver current, and when the RF Multimeter is switched to the "Predriver IDC" position, it acts as a voltmeter, measuring this voltage drop; R23 and R22 are the voltmeter's series multiplier resistors. Resistors R21 and R24-R26 are the voltmeter multiplier resistor when the RF Multimeter is switched to the "Predriver +VDC" position.

C.4.2.5 Predriver RF Sense

One of the unused RF feeds from the A46 Predriver Splitter is used to provide the Predriver RF sense sample. The sample enters the Motherboard at J17-1 and is routed the Predriver Output Sense network and the primary of T20. A peak detector is formed by a secondary winding of T20, CR1, and C10. When RF is present, J31- 15 will have a positive voltage approximately 1/2 the peak-to- peak waveform. Zener diode CR2 limits the detectors' maximum dc output voltage.

C.4.3 Driver Connections - J3 through J16

C.4.3.1 RF Input

The RF drive inputs are obtained from the A46 Predriver Splitter secondary and the driver drive cables that are connected to J18 through J24. Each Driver is provided two equal amplitude and phase RF drive inputs at pins 49 and 53 of each RF Driver connector.

C.4.3.2 Power Supply

Four fused +115VDC lines from the RF Amp Power Supply enters the Driver Combiner Motherboard at E1 through E4. It is connected to each Driver connector at pin 23 and can not be adjusted.

C.4.3.3 RF Output

Each Driver output is connected to a combiner toroid T3 through T16 at pins 1 and 7. The Efficiency Coil boards plug into the Driver Combiner Motherboard at J3-J16 at pins 1 and 4, and their taps are frequency determined.

C.4.4 Driver Encoder Connections - J25 through J28

C.4.4.1 Turn-On Control Signals

On each of the four Driver Encoder connectors, pins 1, 3, 5, and 7 are connected to pin 45 on four Driver connectors. When the voltage is -2VDC on a pin, the Driver is turned on. The same is true for the Predriver on J25-5.

C.4.4.2 Cable Interlock

When an amplifier is properly inserted a connection is made between pins 35/36 and pins 37/38 on the amplifier connector. On each of the four Driver Encoder connectors, pin 9 will loop-through connecting traces/amplifiers/connectors and return to pin 10 with very low resistance. If an amplifier is disconnected, pin 9 and pin 10 will be open circuit.

C.5 Troubleshooting

Most failures on this board can usually be visually identified as burned resistors, open traces, cracked toroids, and loose or damaged connectors. To speed up locating the fault, this section is grouped by major symptom.

WARNING: Disconnect primary power prior to servicing.

CAUTION

THE TRANSMITTER MUST NOT BE OPERATED UNLESS THE COMBINER COVER IS IN PLACE AND ALL SCREWS HOLDING THE COVER TO THE GROUNDING BLOCKS ARE INSTALLED AND PROPERLY TIGHTENED. THE COMBINER COVER CARRIES MOST OF THE COMBINER RETURN CURRENTS.

C.5.1 Driver Troubleshooting

C.5.1.1 No +115VDC to a Driver Amplifier(s)

a. Check the +115VDC supply by watching the DRIVER +VDC position on the Driver Multimeter. It should deflect upscale during step start. If not, then Refer to Section VI, Troubleshooting, to troubleshoot the +115VDC supply.

b. If the +115VDC is present on the meter, but it is suspected that one or more modules is not receiving voltage, then shut the transmitter off for the following checks.

1. Check continuity of the +115VDC supply fuses and connections to each of the driver modules.

CAUTION

It may be necessary to remove the Efficiency Coil Board to accomplish this. DO NOT attempt to turn on the Transmitter with this board removed, amplifier damage will result.

2. If the continuity check does not reveal the problem, then suspect either the capacitors on the module side of the motherboard or the filter capacitors.

C.5.1.2 No Output from a Driver Amplifier

a. Drivers D8, D9, and D10 may not be on because they are frequency determined.

b. Check the DRIVER IDC position on the Driver multimeter, and compare to the factory test data sheet, or a previous log reading.

1. If the reading is low, this indicates that one or more of the modules is not operating. Be sure that the Auto Spare driver is off when taking this reading.
2. Another indication a module is not operating would be the Regulated Driver, 14A and 14B +VDC positions on the Driver multimeter. The 14A +VDC reading will have increased and the 14B +VDC reading may have also increased, to compensate for the lower drive level.

c. If it is suspected that one or more modules is not operating then:

1. Look for lit red blown fuse LEDs on the driver modules either while the transmitter is running or during step start. Repair any module with a red LED lit.
2. If no red indicators are lit on the modules, then check for lit Green indicators on the drivers that are supposed to be turned on.
3. A module that is supposed to be turned on, but does not have the green LED lit has either lost RF Drive or the module Turn on signal from the Driver Encoder.
4. To check RF Drive on the drivers, Refer to Section VI, Troubleshooting Paragraph Title "MEASURING RF DRIVE."
5. If no Drive problem is found refer to the Driver Encoder Troubleshooting section to trace the lost turn on signal.

d. If the amplifier has RF drive, control signal and supply voltage, inspect the motherboard for a bad connector, open trace or cracked toroid.

C.5.1.3 Amplifier Repeatedly Fails in Same Position

If an amplifier position repeatedly fails a Driver Amplifier the most likely causes are:

a. No or low drive on the amplifier
b. Cracked output toroid
c. Bad module connector on motherboard
d. Improperly tapped or connected efficiency coil, or
e. An open Drive trace on the motherboard
f. Check the level of RF drive on the amplifier. Refer to Section VI, Troubleshooting, Paragraph Title "Measuring RF Drive Level".

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. If RF Drive is low or missing inspect the RF drive cable, RF drive connector, and the Predriver Splitter (A46) for a short or open.

g. To locate a cracked toroid, bad connector, or open Drive trace on the motherboard:

1. A visual inspection should be done first.
2. If the visual inspection has revealed nothing an ohmmeter check should be conducted of the traces leading to that amplifier position.

C.5.2 Predriver Troubleshooting

C.5.2.1 No Predriver A or B Voltage

This section starts by assuming there is no voltage to either side of the Predriver Amplifier, when the Predriver select control is operated.

a. If there is no Multimeter reading of Predriver Voltage, verify that the supply is present on the Predriver when Step Start sequence is initiated by observing the PREDRIVER IDC position on the Driver Multimeter. If the voltage is present then there will be a current indication.

1. If not, refer to the Troubleshooting section of the manual for troubleshooting the supply.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

2. If the supply is present check R20, on the Driver Combiner Motherboard, for an open.
3. If R20 checks correct, then check for continuity (low resistance) from J32-1 to pins 1 through 4 on Buffer connector J1.
4. If no continuity refer to the paragraphs that follow.

CAUTION

It may be necessary to remove the Efficiency Coil Board to accomplish this. DO NOT attempt to turn on the transmitter with this board removed, as AMPLIFIER DAMAGE WILL RESULT.

5. If continuity exists, check for continuity from pins 1 through 4 on the Buffer connector J1 to pins 23 through 26 on Predriver connector J2. (The Buffer Amplifier should be in its connector).
6. If continuity exists, suspect a bad connector.
7. If this line measures open, check for continuity between pins 1 through 4 on J1 to pins 23 through 26 on Buffer connector J1 with Buffer Amplifier in place.
8. If continuity exists, then a trace is open between J1 and J2.
9. If no continuity then suspect a bad J1 or open F1 on the Buffer Amplifier.
10. If no continuity exists between J32-1 and Pins 1 through 4 on J1 then remove the Buffer and Predriver modules.

C.5.2.2 Verify Predriver Select Relay Operation, K1 and K2

a. Switch between Predriver A and B on the Driver Encoder Board and verify that K1 and K2 are operating.
   1. If only one relay operates the non-switching relay is defective or a trace is open.
   2. If K1 operates but there is no continuity between J32-1 and Pins 1 through 4 on J1 in the "A" position then suspect bad contacts of K1 or an open trace.
   3. If K1 operates and there is no continuity between J32-1 and Pins 7 through 12 on J1 in the "B" position, suspect bad contacts of K1 or an open trace.

b. If K1 and K2 do not operate check for +15VDC on J31-17 when A is selected and for 0 VDC when B is selected.
   1. If J31-17 does not change states, check for an open trace on the board or open cable coming from the Driver Encoder. Refer to the Driver Encoder Troubleshooting Section to continue.

c. If the signal changes state but the relays do not operate, an open coil on K1 or K2, or a shorted CR7 may be at fault.

C.5.2.3 No RF Out of Predriver A or B

a. Verify that it is not an amplifier fault by swapping the Predriver with another position Driver Amplifier.

b. If still no output, check for turn on signal presence during step start (Green LED on).
   1. If no signal is present, check for an open trace on the motherboard or an open cable from Driver Encoder.
   2. If no problem is found, refer to the Driver Encoder Troubleshooting Section.

c. Check for Supply Voltage for the Predriver during Step Start sequence with the PREDRIVER +VDC position on the Driver Multimeter.
   1. If the voltage is present at the meter, then check the PREDRIVER IDC reading. No current indication would mean the voltage is not getting to the Predriver module.
   2. If the voltage or current reading is not present, then refer to "No Predriver A or B Voltage" of this section to troubleshoot loss of the supply.

d. Remove the Predriver Module and verify that K2 on the Motherboard operates when the Predrivers are selected on the Driver Encoder.
   1. If K2 does not operate refer to previous paragraph titled "Verify Predriver Select Relay Operation, K1 and K2".

e. Determine that RF drive is getting to the Predriver during the Step Start sequence. Refer to Section VI, Troubleshooting, Paragraph Title "Measuring RF Drive Level".
   1. If no Drive is present at the Predriver, refer to the Buffer Amplifier Troubleshooting Section and/or inspect the motherboard for an open trace or bad connector.

C.5.3 Loss of Metering and\or RF Sensing

The metering and RF sensing circuits are all connected to J31 on the motherboard.

To begin:

a. Verify the presence of the signal on the connector.
   1. If missing, an open resistor, shorted diode, or open trace associated with that metering circuit on the motherboard may be at fault.
   2. If present refer to the overall wiring diagram to trace the wiring to the proper board.

WARNING: Disconnect primary power prior to servicing.

C.6 Driver Combiner Motherboard Removal/Replacement

C.6.1 Removal

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Remove the Buffer, Predriver and 14 Driver RF Amplifiers from the front.
b. Remove the four Efficiency Coil Boards from the motherboard.
c. Disconnect all wiring and cables from the motherboard.
d. Remove the 24 Allen screws and pull the combiner cover out the rear of the transmitter.

CAUTION

LOCATE AND REMOVE ANY HARDWARE THAT IS DROPPED. IF LOST HARDWARE IS REPLACED, MAKE SURE NONE OF IT HAS LODGED ON ANY RF AMPLIFIER.

e. The secondary combiner rod will have to be removed through the top of the transmitter.
    1. Remove the bolt that attaches the combiner rod to the RF Splitter.
    2. Remove the access plate on top of the transmitter above the L1/C2 assembly.
    3. Disconnect the L1 assembly from the top of the combiner rod.
    4. Loosen the two set screws that are on the fiberglass supports on the motherboard that hold the rod in place.
    5. Lift the combiner rod out the top of the transmitter.
f. Remove the following motherboard fastening hardware.
    1. Two 4-40 screws in the front center card guide support. The 4-40 screws to be removed can be identified by the 6 inch (15cm) aluminum rods attached to the card guide support bar.
    2. Six screws on the outside right and left sides of the motherboard.
    3. Four screws on the inside top and bottom of the motherboard.
g. Carefully remove the motherboard out the rear of the transmitter, tilting it somewhat to clear the driver drive cables housing unit.

C.6.2 Replacement

Replacement of the motherboard is essentially the reverse of the removal procedure, however note the following:

a. During installation of a motherboard, it may not appear to fit in as easily as it came out. This is due to the blue card guides not fitting back in their slots at the same time. It is recommended that the board be installed and just a few of the screws be installed that mount the board to the supports. Then from the front of the compartment, place the card guides into their respective slots.
b. Tighten the Allen screws on the copper rod to 150 inch/lbs.
c. Retighten the set screws on the motherboard.

CAUTION

REPLACE ALL COMBINER COVER SCREWS. THE MAJORITY OF COMBINER RF GROUND CURRENT FLOWS THROUGH THE COMBINER COVERS.

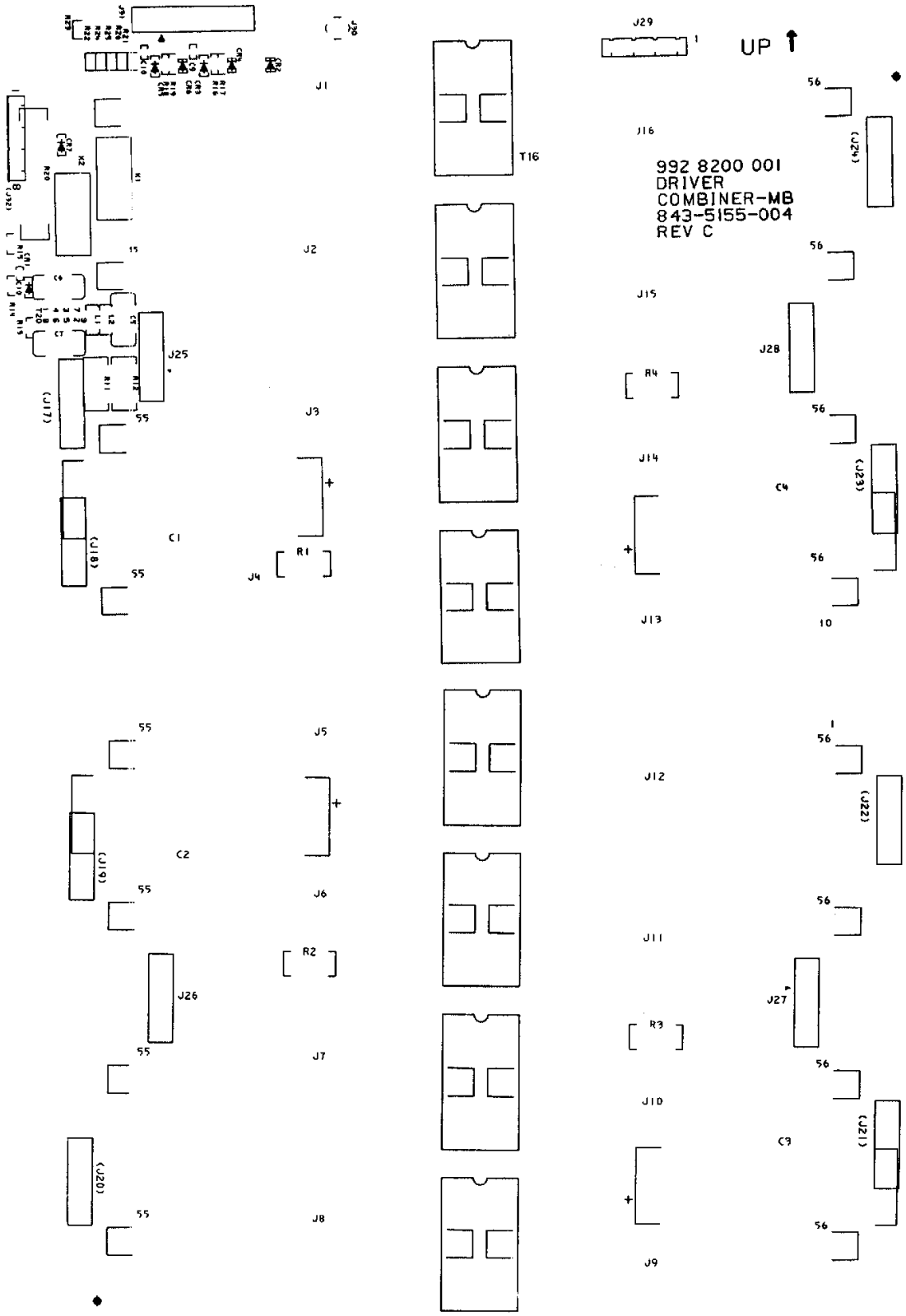


Figure C-2. Driver Combiner MB - Component Locator

WARNING: Disconnect primary power prior to servicing.

C.7 Buffer Amplifier (A4)

C.7.1 Introduction

This section covers the Buffer Amplifier board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal/replacement.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE: Parts List for this board is covered in Section VII.

C.7.2 Function

The Buffer Amplifier includes Buffer and Push Pull Amplifiers used to amplify the RF signal. The Buffer Amplifier RF input comes from the RF Interface, and the amplified RF output signal drives both sections of the Predriver. All connections to and from the Buffer Amplifier as well as Buffer Amplifier Fault Sensing are made on the Driver Combiner Motherboard.

C.7.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100kW with no modulation at 540kHz carrier frequency.

C.7.4 Location

The Buffer Amplifier board is located inside the right PA compartment, behind the inner door, at the top left hand corner. (SEE VIEW 10)

C.7.5 Block Diagram Description

C.7.5.1 RF Flow

Refer to Buffer Amplifier Block Diagram, Figure C-3 for the following discussion.

The Buffer Amplifier board contains two identical halves, Section A and Section B which are always actively driving separate halves of the Predriver. Each section has two levels of amplification. Buffers accept the 4 to 4.5Vp-p RF input from the RF Interface board and drive the second stage using coupling Transformers. Class D Push-Pull Amplifiers stages are Filtered and drive both sections of the Pre-Driver board.

C.7.5.2 Power Supplies

A single variable dc supply (+20 to +45VDC) is regulated to +15VDC for the Buffers and is applied directly to the Push-Pull Amplifiers.

C.7.5.3 Predriver Supply

The Predriver Supply voltage is fused on the Buffer Amplifier before being sent to the Predriver. Only one half of the Predriver has dc voltage at a time. This is determined by switch S5, on the Driver Encoder Board, and relay K1, on the Driver Combiner Motherboard.

C.7.6 Detailed Circuit Description

Refer to the Buffer Amplifier Schematic Diagram (839-7930-014), for the following discussion.

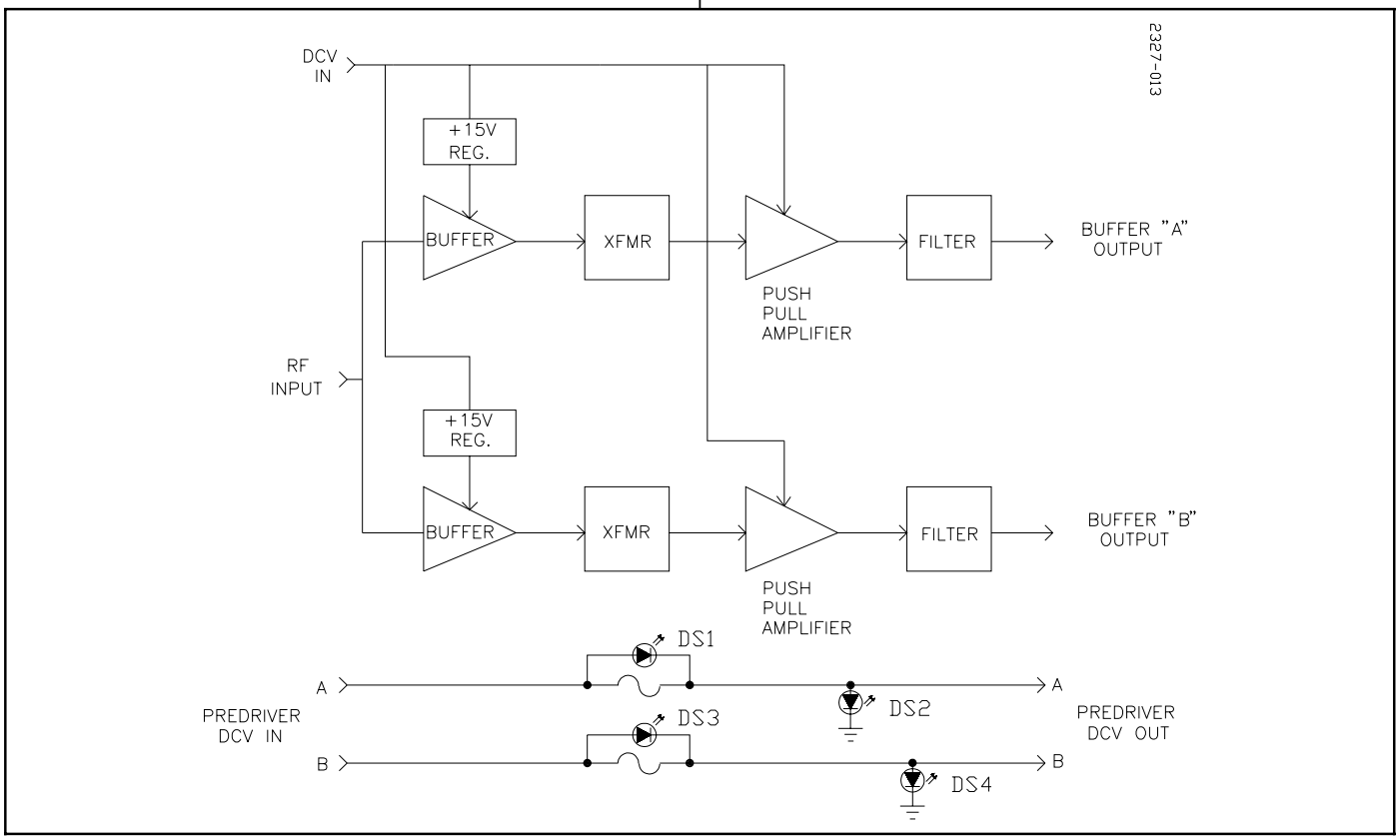


Figure C-3. Buffer Amplifier Block Diagram

WARNING: Disconnect primary power prior to servicing.

Since the two sections of the Buffer Amplifier Module are identical only Section A will be described here.

C.7.6.1 Buffer Amplifier

The RF input at P1-15 from the RF Interface board is a 4 to 4.5Vp-p square wave into the 50-ohm impedance provided by R16. The first RF amplifier stage consists of U1, two parallel drivers, used as a buffer-driver stage. The output of U1 is a square wave at TP1 A drive, with an amplitude of approximately 15 Vp-p. Diodes CR2 and CR4 provide protection against possible transients and overvoltages.

C.7.6.2 Transformer

C8, C10, L1, and R12 are a broadband series tuned coupling network, between amplifier U1 and the primary winding of coupling transformer T1. The upper secondary is connected to the gate of Q1 and the output at TP2, the lower secondary is connected to the gate of Q2 and ground.

C.7.6.3 Push-Pull Amplifier

This RF amplifier stage consists of two power MOSFETs in series, which are driven in Class D (switching) mode. The two RF drive signals to the MOSFET gates are 180° out of phase. Q1 and Q2 are therefore turned on alternately, and the output of the stage alternates between ground and the supply voltage.

CR3 and CR5 protect the MOSFET gates against overvoltages and resistors R9 and R14 are for parasitic suppression.

C.7.6.4 Filter

The output of the Q1-Q2 amplifier stage at TP2, A Out, is applied to a broad-band coupling network formed by C9, L2 and a swamping resistor network. RF OUT SIDE A at P1-49 is connected to the Driver Combiner Motherboard, where it is sent to the Predriver.

C.7.6.5 Power Supplies

The Buffer Amplifier is connected to the +60VDC supply through 3F14 (in the Power Supply Compartment), Buffer Supply Adjust 1R2, and enters the Driver Combiner Motherboard at J32-3. The supply voltage input at P1-41 can vary between +20-45 VDC and is used to set the RF drive level to the Predriver.

The input is fused with 2 amp fuses F3 and F4. Red LED indicators DS5 and DS6 will illuminate when F3 or F4 are open, and are visible from the non-interlocked compartment.

The Push-Pull Amplifier stage operates directly from the input supply. R7 and the associated capacitors form a de-coupling network.

U1 operates from +15VDC, regulated by three 5.1V zener diodes CR1, CR11 and CR12 and dropping resistors R6 and R37.

C.7.6.6 Predriver Supply

The Predriver supply voltage is fused on the Buffer Amplifier by F1 and F2 in order to provide proper fusing of 4 amps (fuses on the RF Amplifier Module are 6A). This allows any of the RF Amplifiers to be used in the Predriver position (except the Buffer Amplifier). Red LED indicators DS1 and DS3 will illuminate when F1 or F2 are open. Green LED indicator DS2 will illuminate when Predriver A supply is present, and DS4 when Predriver B supply is present. All indicators are visible from the transmitter's non-interlocked compartment.

C.7.7 Troubleshooting

The Buffer Amplifier supply voltage will not be present when the transmitter is off. The first step in troubleshooting this board is to observe the red LEDs on the module during Step Start.

C.7.7.1 Switch To Predriver B

If Buffer Amplifier Section A has failed, there will be no RF drive to Predriver A. Switching to Predriver B will select Buffer Amplifier Section B output for operation. Move the Predriver Select Switch S5 on the Driver Encoder to the B position, and turn on the transmitter again. If the transmitter stays on with no Buffer Amplifier fault, Buffer Amplifier Section A has failed.

C.7.7.1.1 DS5 illuminated

If DS5 is lit, F3 has failed.

a. Check MOSFET's Q1 and Q2 for a short and replace as needed.
b. If the MOSFET's measure correctly with an Ohmmeter, check for a shorted CR1, CR11, and/or CR12.
c. If the diodes check okay, measure the capacitors C1 through C5 on that line to ground.

C.7.7.1.2 DS6 Illuminated

If DS6 is lit, F4 has failed.

a. Check MOSFET's Q3 and Q4 for a short and replace as needed.
b. If the MOSFET's measure correctly with an Ohmmeter, check for a shorted CR6, CR13, and/or CR14.
c. If the diodes check okay, measure the capacitors C12 through C15 on that line to ground.

C.7.7.1.3 DS1 or DS2 Illuminated

If these LEDs are lit, F1 or F2 respectively has failed.

This indicates that the Predriver or the Driver Combiner has a fault. Refer to the RF AMP Section to troubleshoot the Predriver Module and the Driver Combiner Section to continue.

C.7.7.1.4 No Red Indicators Illuminated

Note

Buffer A and Buffer B are identical, therefore only Buffer A will be discussed here. To Troubleshoot Buffer B simply use the appropriate component or Test Points as they relate to Buffer B.

If Buffer A has no output and DS5 is not illuminated during Step Start:

a. First determine if the Buffer is receiving RF Drive.

WARNING

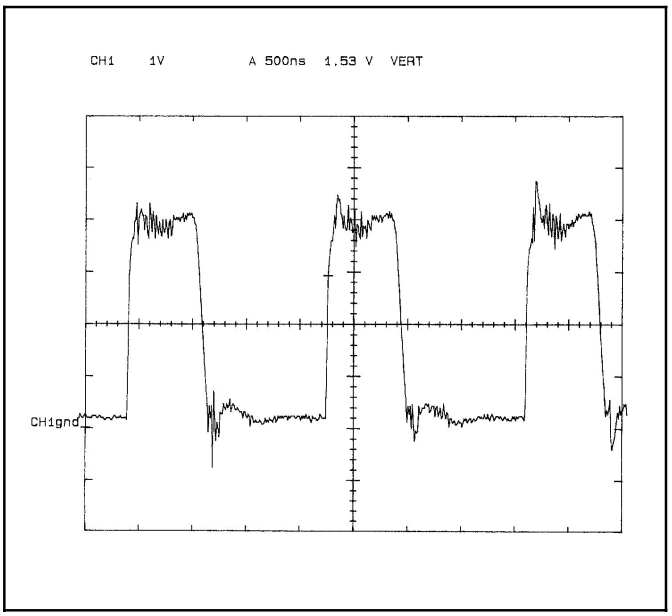
ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

1. Pull out the Buffer module and attach a clip lead onto the front end of R16.
2. Reinsert Buffer Module
3. Route the clip lead through the air holes in the inner door so the door can be closed.
4. Connect a scope probe to the clip lead, and turn on only the Low voltage. There should be a 4 to 4.5Vp-p RF signal present.
5. If not, then refer to the overall wiring diagram and Frequency Synthesizer Troubleshooting to trace the loss of signal.
6. If the RF is present, then check the DC supply voltage to the Buffer.

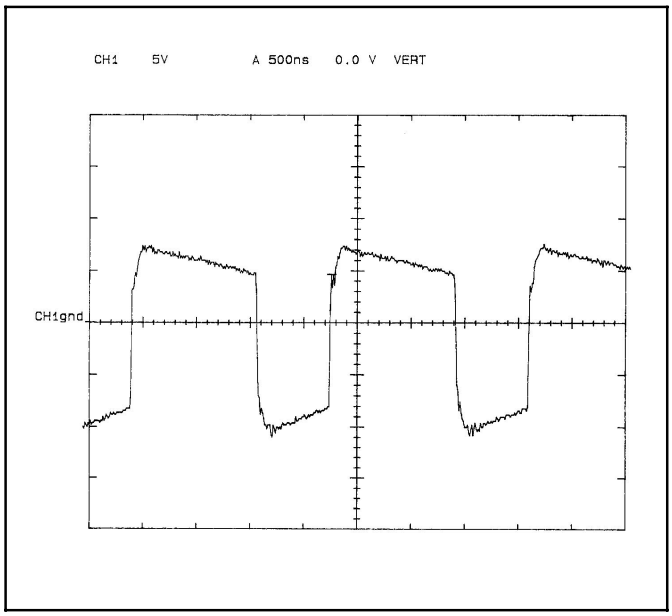
b. Determining that the DC Supply voltage is present on the module during Step Start sequence can be done by placing the probe (610-1131-000) or equivalent X10 probe on the Drain of Q1. During step start you should see a +20-45VDC signal.
   1. If this is not present refer to Section VI, Troubleshooting, the Overall wiring diagram, and the Driver Combiner schematic to trace the missing voltage.

c. If the supply voltage is present, verify that an RF drive waveform is present at the output of Buffer A during the Step Start sequence.
   1. Then look at Buffer B output and verify the presence of the same waveform.
   2. If both outputs have an RF signal refer to the Driver Combiner Schematic to locate a missing trace or bad connector.
   3. If both outputs do not have an RF signal, check TP1 for a 15Vp-p RF signal during step start and replace U1 if missing. (RF Drive to the input of U1 was verified in a previous step).

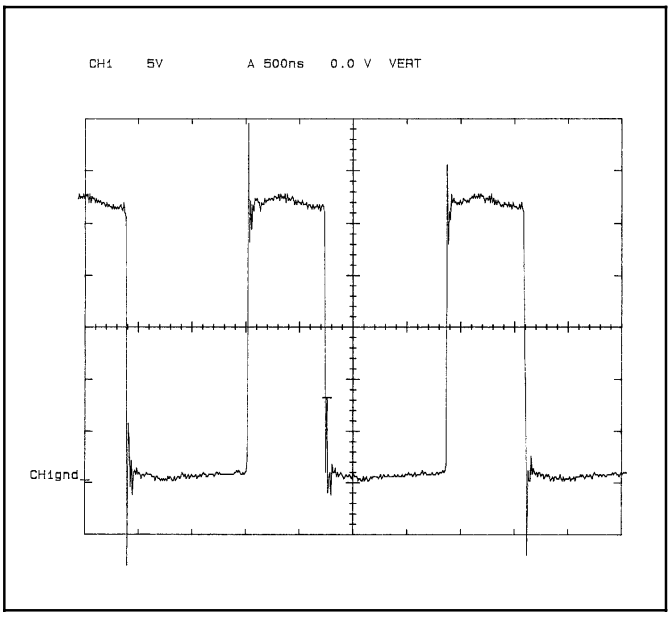
WARNING: Disconnect primary power prior to servicing.



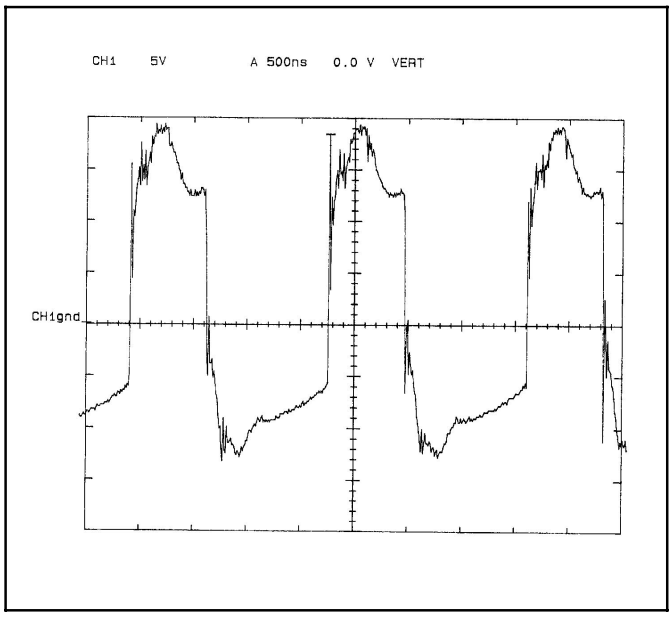
P1-15



TP1



TP2



P1-49

WARNING: Disconnect primary power prior to servicing.

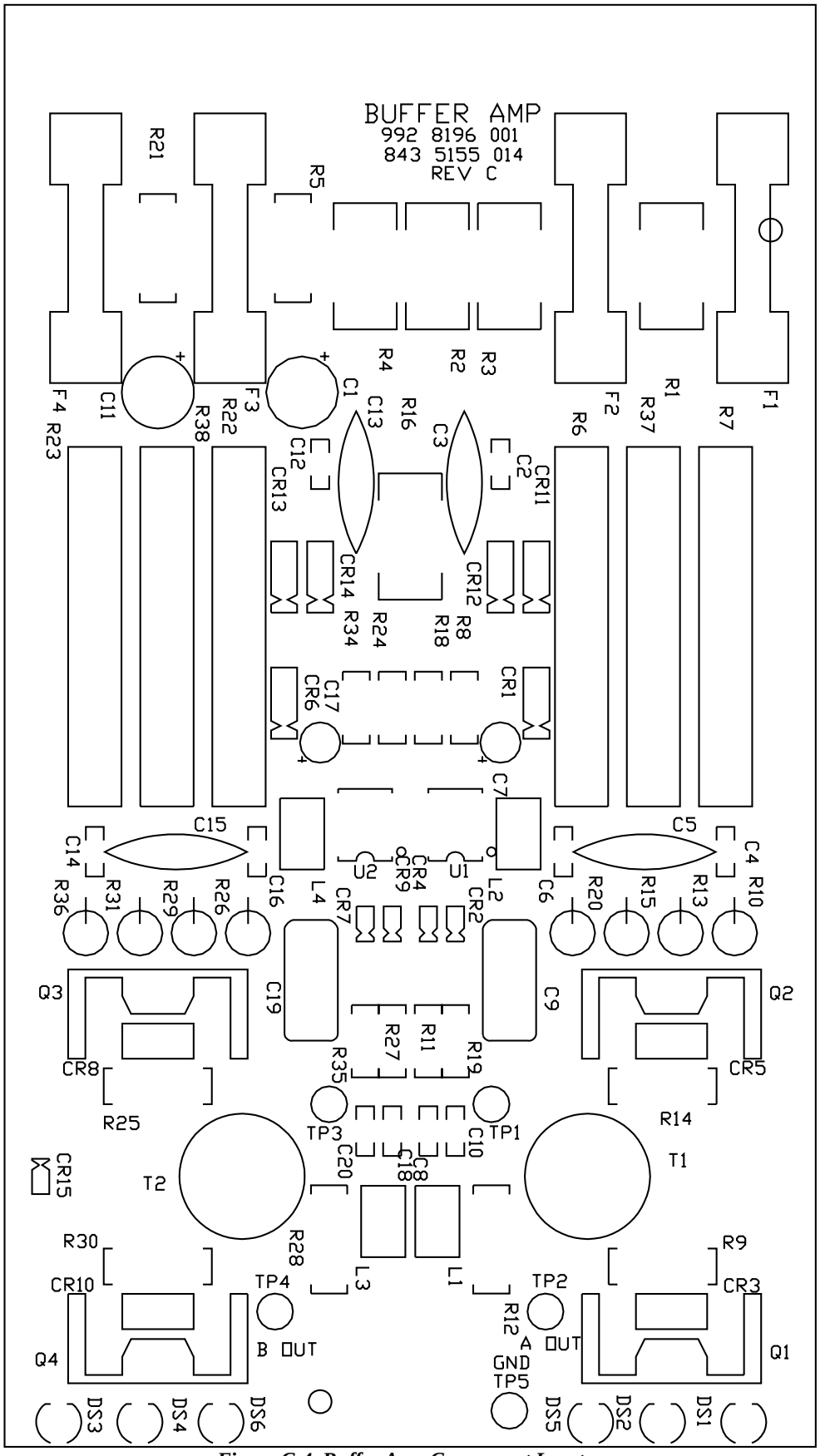


Figure C-4. Buffer Amp Component Locator

WARNING: Disconnect primary power prior to servicing.

C.8 Predriver, PD1

C.8.1 Introduction

This section describes the Predriver module. Topics include Function, Location, and Troubleshooting.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section.

NOTE: For detailed circuit description and troubleshooting refer to Section G, RF Amplifiers.

C.8.2 Function

The Predriver module, PD1, is used to amplify the Buffer Amplifier output and provide RF Drive to Drivers D1-D14. The Predriver module is a plug in RF amplifier identical to and interchangeable with any of the RF Amplifiers.

C.8.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100kW with no modulation at 540kHz carrier frequency.

C.8.4 Location

The Predriver module (PD1) is located in the right PA compartment behind the inner door on the upper left hand side. (See VIEW 10)

C.8.5 Block Diagram Description

Refer to Figure C-5, Predriver Select Simplified Block Diagram.

C.8.5.1 Predriver Switching

The Predriver module is used in the Single-ended or Half Quad configuration, which means that only one half of the amplifier is activated at a time. Each half of the Predriver receives RF drive from the corresponding half of the Buffer amplifier. The output of the Predriver goes through the Predriver Tuning board then to Predriver Splitter, A46, which feeds the RF Drivers, D1- D14.

C.8.6 Power Supply

The Predriver dc supply is switched by the Predriver Tuning board and R1, Predriver Voltage Adjust. The Predriver dc supply voltage, fuses and indicators are on the Buffer Amplifier. This makes the Predriver interchangeable with the other RF Amplifiers in the transmitter without having to change the fuses.

Predriver Voltage and current metering samples are taken from the Driver Combiner/Motherboard, and can be checked at the Driver Multimeter.(SEE VIEW 11)

C.8.7 Troubleshooting

C.8.7.1 Predriver Select

Predriver A should be selected for normal operation. If Predriver A should happen to fail it will be necessary to switch to Predriver B. This can be done by remote control or manually by activating S5 on the Driver Encoder. S5 will activate K1 and K2 on the Driver Combiner/Motherboard. K1 switches the Predriver supply from Predriver A to Predriver B and K2 removes the ground from Predriver B output and places the ground on Predriver A output.

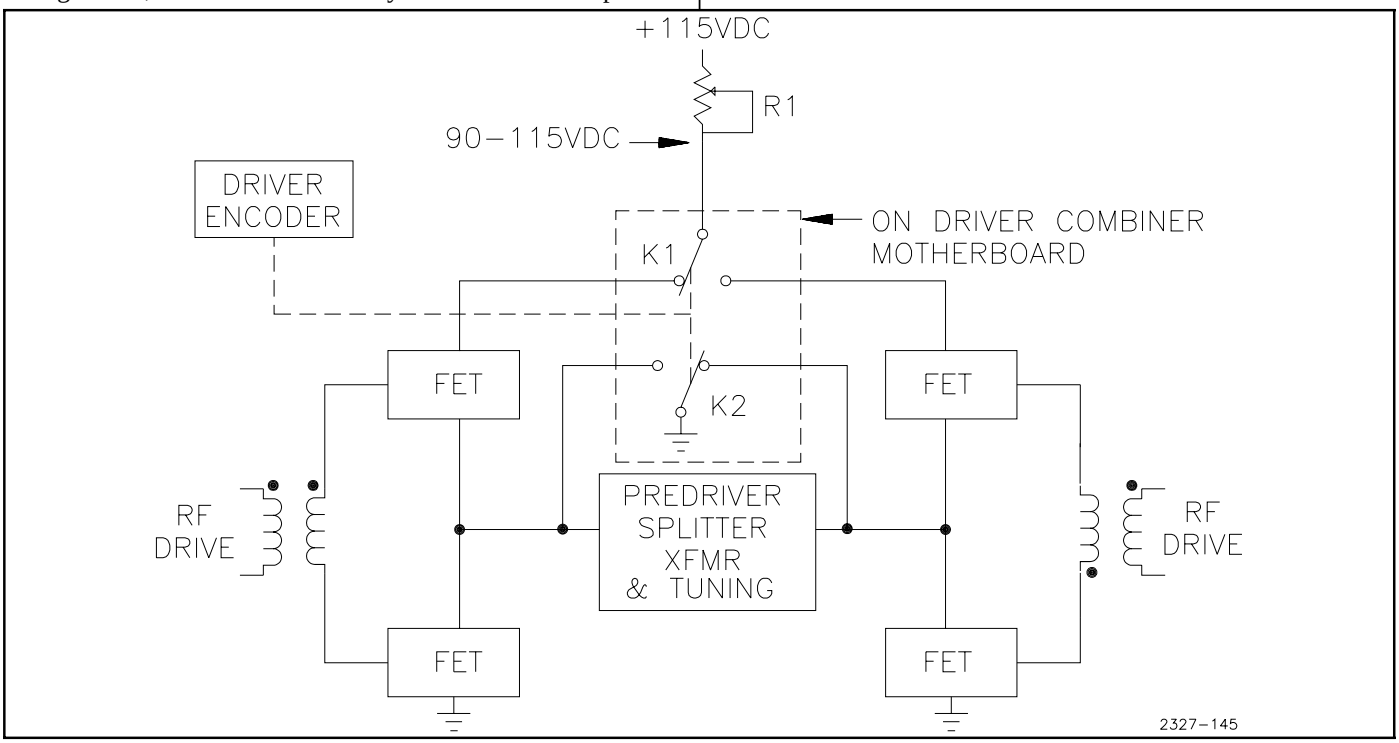
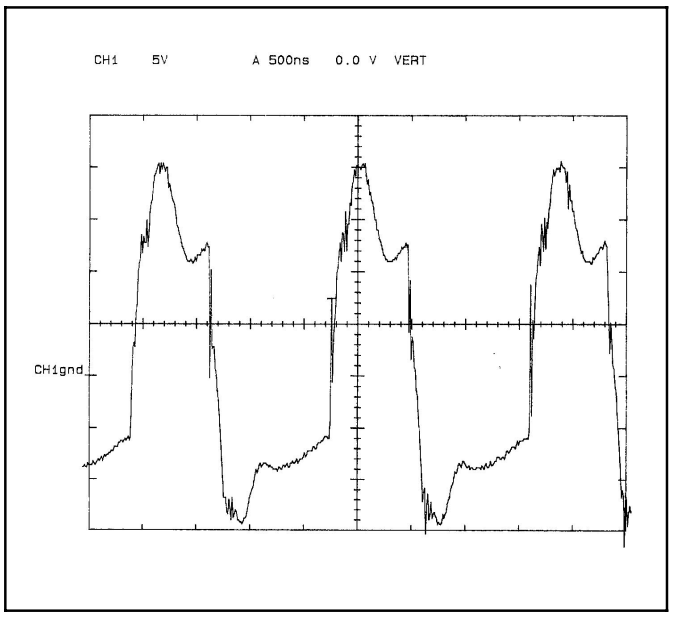
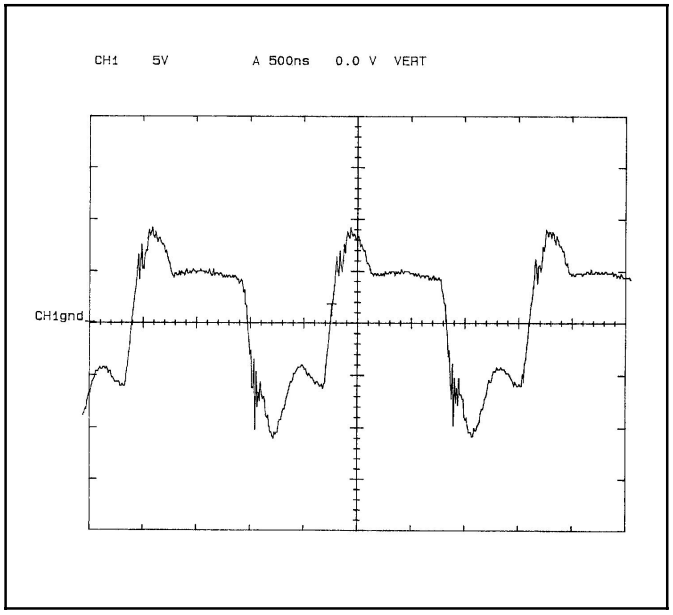


Figure C-5. Predriver Select Simplified Block Diagram

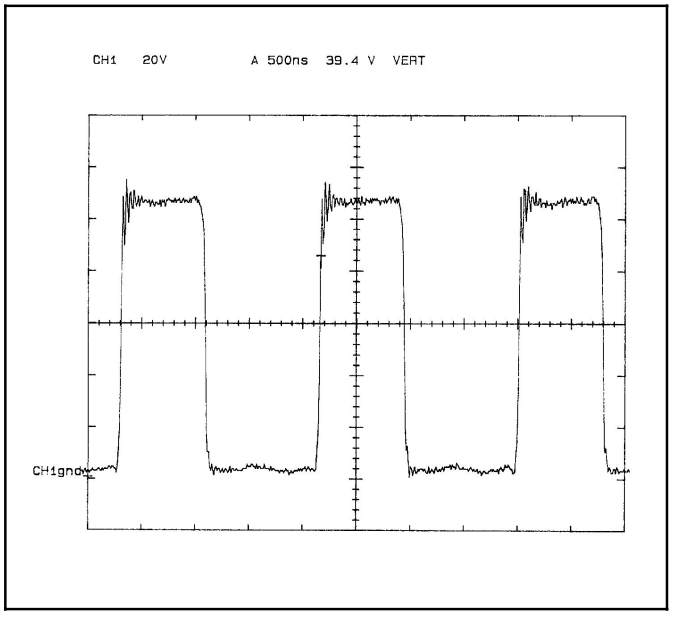
WARNING: Disconnect primary power prior to servicing.



P1-50



Q7 Gate



TP1

WARNING: Disconnect primary power prior to servicing.

C.9 Drivers, D1 through D14

C.9.1 Introduction

This section describes the Driver Amplifiers. Topics include, Function and Location.

NOTE: For more information about the RF Driver Section, refer to the Overall System Theory Section and to the Driver Encoder.

NOTE: For detailed circuit description and troubleshooting refer to Section G, RF Amplifiers.

C.9.2 Function

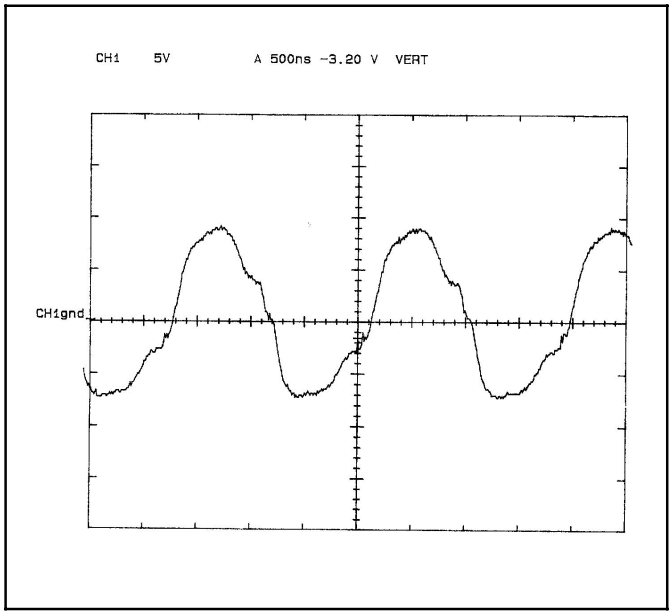
The Driver RF Amplifiers, D1 through D14 are used to amplify the Predriver output and provide RF Drive to all Big Step and Binary RF Amplifiers. The Driver RF Amplifiers are plug in RF Amplifiers identical to and interchangeable with any of the Big Step and Binary RF Amplifiers and the Predriver.

C.9.3 Oscilloscope Waveform Plots

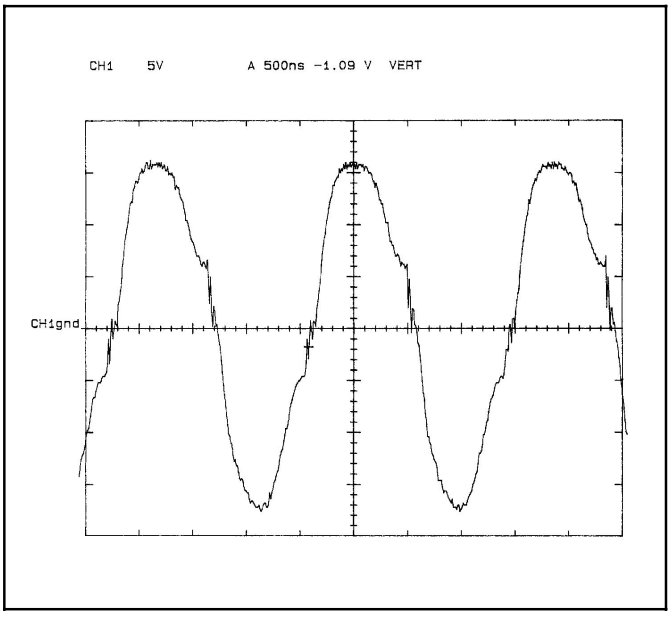
Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100kW with no modulation at 540kHz carrier frequency.

C.9.4 Location

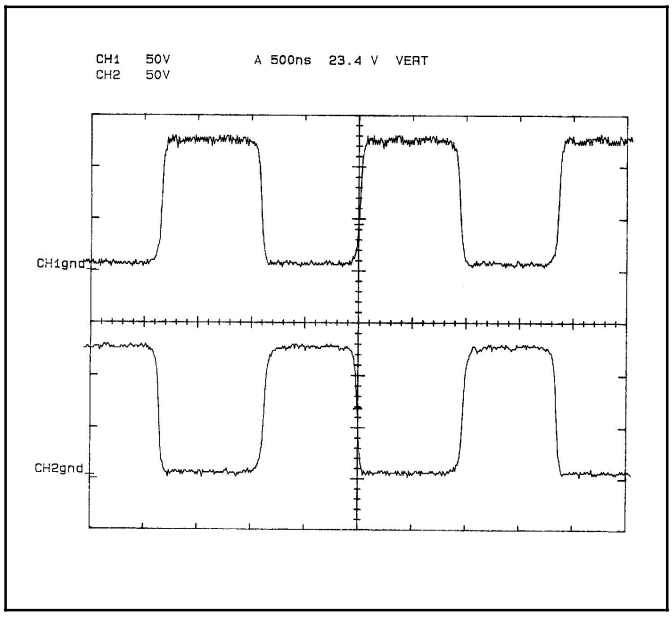
The Driver RF Amplifiers are located behind the inner front door on the left, center, and right Compartments. (SEE VIEW 10).



Q7 Gate



P1-50



CH1 TP1

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D.1 Introduction

This section covers the Predriver Tuning board. Topics include function, location, detailed circuit description, troubleshooting, and removal\replacement.

NOTE: Parts List for this board is covered in Section VII.

D.2 Function

The function of the Predriver Tuning board is to series tune the output of the Predriver amplifier to resonance through the frequency range of the transmitter. The Predriver Tuning board contains the tuning inductance and capacitance along with switching relays that are controlled by an external 5 Bit signal. The Predriver Tuning board also contains the Predriver Level Adjust relay.

D.3 Location

The Predriver Tuning board is located in the left rear PA compartment on the upper right side. (SEE VIEW 15)

D.4 Detailed Circuit Description

Refer to the schematic diagram for the Predriver Tuning board (839-7930-511) for all descriptions in this section.

D.4.1 RF Input

The Predriver amplifier RF output from J33 on the Driver Combiner Motherboard, is connected to this board via a BNC J2. It is connected to L1 and K1.

D.4.2 Tuning Components

Series tuning through the frequency range is accomplished by switching in inductors and/or capacitors in a binary weighted manner. Inductors L1 and L3 have taps, while L2 and C7 through C9 have fixed values. Most points in the circuit are connected to relay contacts to allow different arrangements.

D.4.3 RF Output

The output of the tuning assembly is found at terminal strip TB1 which allows a direct connection to the Predriver Splitter transformer. The remainder of the series tuned circuit is completed with the variable inductor L1 which is used for fine adjustment of resonance during initial setup.

The taps on the Predriver Splitter transformer JP1 through JP3 allow selection of optimum loading of the Predriver. This adjustment is intended to be a one time adjustment to cover the entire frequency range.

D.4.4 Switching Relays

Relays K1 through K5 require +24VDC across the coil to energize. They are controlled by the 5 Bit input from J1, all of the + pin 1 inputs are connected to +24VDC. The - pin 2 inputs are connected to current switches to ground via the Frequency Control Interface board.

D.4.5 Bit 0 through Bit 4 Input

The 5 Bit input from the Frequency Control Interface enter the board on J1. They are frequency determined inputs that are used to activate the relays and tune the circuit. The use of 5 bits yields 32 bands which have low enough Q to allow the Predriver to be at resonance at any RF frequency to produce sufficient Driver RF drive.

The most significant bits BIT 4 and BIT 3 use both contacts of the relay to select between inductance and capacitance. The least significant bits only switch in and out binary weighted values of inductance.

NOTE

For more details on the 5 Bit input, refer to the Transmitter Band Chart information in the Frequency Control Interface section.

D.4.6 Predriver Level Adjustment

This board also controls the switchable tapped resistor on the Predriver input voltage for optimizing Predriver output depending on the transmitter frequency. The Predriver Level Adjust Relay K6 is controlled by Bit 0 from the Frequency Control Interface board. When energized the relay will short out a section of tapable resistor R1, which is in series with the Predriver power supply.

D.4.7 Interlock

A single trace jumpers from J1-15 to J1-8, and is part of the +24VDC Interlock circuit.

D.5 Predriver Tuning Board Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Failure of the Predriver Tuning board would most likely result in a Predriver and Low Drive Fault.

D.5.1 Verify The 5 Bit Input

Check that the correct control voltages for the relays is present on the Frequency Control Interface, using the Transmitter Band Chart as a guide.

NOTE

For more details on the 5 Bit input, refer to the Transmitter Band Chart information in the Frequency Control Interface section.

The +24VDC supply may be measured on J1-9 through J1-14. If the relay is to be energized, the Bit input must be 0VDC as

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measured on the output pin of U1. If the relay is to be de-energized, the Bit input must be an open circuit and should therefore measure +24VDC.

D.5.2 Relay Ohmmeter Testing

Relays may be ohmmeter tested using a power supply, by applying +24VDC to the + pin 1 input and ground to the - pin 2 input. The relay should make a "clicking" sound when energizing. The contacts can also be checked for open/closed continuity.

D.5.3 Visual Inspection

With the assembly removed, visually inspect the tapped inductor connections and the capacitor mounting hardware for loose contacts.

D.6 Removal\Replacement

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

NOTE

The Predriver Tuning board is mounted to a metal angle bracket assembly that is held in place by 3 screws.

Remove all connectors and the single front screw from the inside of the right PA compartment. Remove the 2 remaining screws from the rear of the transmitter and lift out the assembly from behind. Remove connections from TB1.

When installing a new board, verify that all jumpers on the new board are in the same position as the jumpers on the original board.

D.7 Alignment

There are no alignments on this board.

The board is factory tuned and should not require readjustment. However if mistuning of the Predriver is suspected, operate at 1600 kHz and adjust Predriver Tuning L1 for a peak in Predriver current as indicated on the Drive Multimeter.

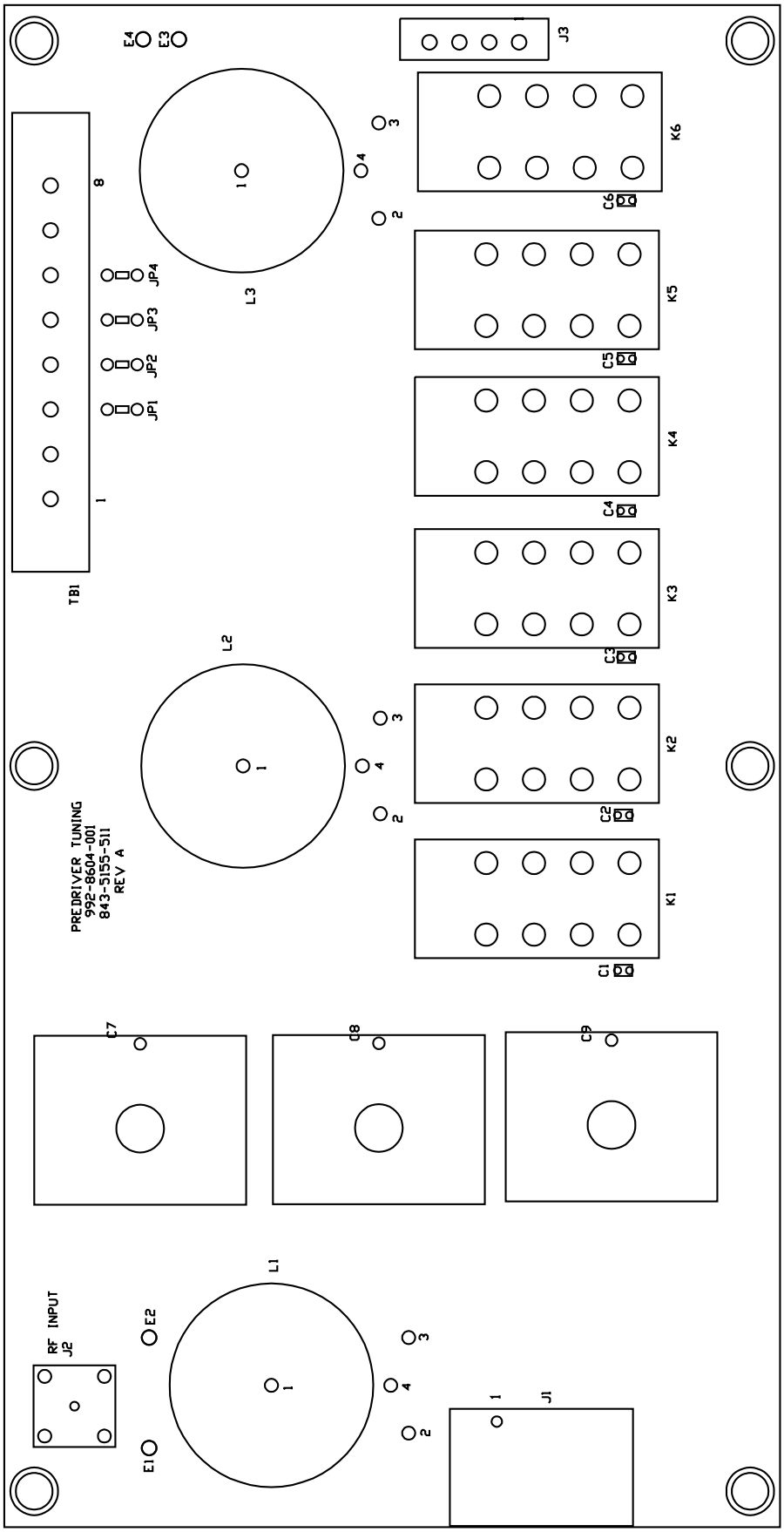

Figure D-1. Predriver Tuning Board Component Locator

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WARNING: Disconnect primary power prior to servicing.

E.1 Introduction

This section covers the Driver Encoder board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, removal/replacement, and alignment.

NOTE: Parts List for this board is in Section VII.

E.2 Function

The main function of the Driver Encoder board is to provide turn-on control signals to the Predriver and 14 RF Driver Amplifiers. It also monitors RF drive levels and provides Buffer, Predriver, and High/Low Drive Fault sensing and metering. The board provides for selection of Predriver A or B, and monitors Module and Cable Interlock status lines. It receives an RF drive sample and processes the sample for the A/D Converter. This board also has circuitry to monitor the temperature of the +230VDC RF Amplifier Power Supply rectifier heat sinks.

E.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100 kW with no modulation at 540 kHz carrier frequency.

E.4 Location

The Driver Encoder is located inside the right front PA compartment on the lower right hand side. (SEE VIEW 10)

E.5 Block Diagram Description

Refer to Sheet 1 of the schematic for the Driver Encoder board 839-7930-510 for the following discussion.

E.5.1 A/D Sample Drive

The RF Drive Sample In from the RF Splitter is applied to the Digital Phase Adjustment circuits and a Programmable Frequency Divider will divide the frequency if required.

The Output Buffer connects the RF phase shifted TTL level squarewaves that form the A/D Sample Drive, to the A/D Converter board.

A/D Phase Data Inputs are used to control the amount of phase adjustment, while the A/D Frequency Data Input controls the divider. Band indicators allow a visual indication of input data, and manual adjustments are not used in non-frequency agile applications.

E.5.2 Encoder Outputs

When a Turn On Request is received from the Controller, the Driver Encoder Logic will turn on the fixed Drivers, Band-switched Drivers, AGC Drivers, and the Predriver through the Encoder Output Drivers. The number of RF Drivers turned on will be determined by the Driver Level Band Data, the Driver AGC Comparators, and the Run Contactor Status input.

When the Turn On Request is removed, the Predriver and all RF Drivers are turned off.

E.5.3 RF Drive Level Sensing

An RF Drive Sample from the RF Splitter is applied to the Drive Input Circuit, which simulates the input of an RF Amplifier. The output of this circuit feeds a Drive Rectifier, which converts the RF signal to a DC voltage proportional to the RF drive level applied to all RF Amplifiers.

This DC voltage is applied to a High Drive Comparator and a Low Drive Comparator. If the RF drive level is too high, it will be detected by the High Drive Comparator and a High Drive Fault will be sent to the Controller. If the RF drive level is too low, it will be detected by the Low Drive Comparator and a Low Drive Fault will be sent to the Controller.

The same DC voltage is connected to the Driver AGC Comparators whose outputs are used by the Driver Encoder Logic to control the AGC Drivers.

The same DC voltage is applied to a Sample Buffer that provides a Driver Sample for metering purposes.

The Auto Driver On/Off Comparator and the Auto Driver Select switch are installed on the board, however they are not being used in this configuration.

E.5.4 Module/Cable Interlock

The Driver Encoder Board provides a Module/Cable Interlock status output signal to the Controller. If the Predriver, or any one of the 14 RF Driver Amplifiers modules is removed (or not fully connected), a Cable Interlock Fault will prevent the transmitter from being turned on.

If an encoder cable between the Driver Encoder board and the Driver Combiner Motherboard is disconnected, the same fault occurs.

E.5.5 Predriver B Select

Predriver A is normally in operation, but should it be necessary, Predriver B can be used. This is accomplished by either the Predriver Select switch or Remote Predriver B Select control input. Either input to the Predriver Select circuits will generate a Predriver Mute while a Predriver Relay Drive output switches to Predriver B.

E.5.6 Buffer/Predriver Sensing

RF output samples are taken from the Driver Combiner Motherboard for Buffer Amplifier A and Buffer Amplifier B and applied

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to Fault Sensing circuits. Both Buffer Amplifiers are continuously operating and normally Predriver A is selected for operation. Fault Sensing therefore monitors Buffer A output, until Predriver B is selected at which time Buffer B is monitored. Should the Buffer Amplifier sample being monitored not be present, a Buffer Fault will be sent to the Controller.

The same DC voltages are applied to a Sample Buffer that provides a Buffer Sample for metering purposes.

An RF output sample is taken from the Driver Combiner Motherboard for the active Predriver A or B and applied to a Fault Sensing circuit. Should the active Predriver sample not be present, a Predriver Fault will be sent to the Controller.

The same DC voltages are applied to a Sample Buffer that provides a Predriver Sample for metering purposes.

E.5.7 Power Supply Temperature Sensing

The Power Supply Temperature Sensor Inputs, from the RF Amp Power Supply rectifier heat sinks, are connected to Sensor Buffers and then to the Power Supply Fault Comparators. If the heat sink temperature should rise above a preset reference level, a Power Supply Temperature-Foldback Fault will be generated and the transmitter power output will automatically Foldback in steps. If the heat sink temperature continues to rise, a Power Supply Temperature-Off Fault will be generated and the transmitter will shut off.

E.5.8 Power Supplies

An unregulated +22VDC is regulated down to +15VDC, +8VDC is regulated down to +5VDC, and -8VDC is regulated down to -5VDC, to power circuits on the board.

A Fault Sensing circuit monitors these supplies and will generate a Supply Fault for the Controller.

E.6 Detailed Circuit Description

Refer to the schematic diagram for the Driver Encoder board (839- 7930-510) for all descriptions in this section.

E.6.1 Driver Amplifier Control

The Driver Amplifier control uses 2 PALS that provide the turn-on/off control voltages for the 14 Driver Amplifiers. It is used so that approximately 21Vp-p of RF drive is applied all 160 Big Step and Binary RF Amplifiers over the entire frequency band. Drivers D1 though D7 are always turned on, Drivers D8 through D10 are frequency determined, and Drivers D11 through D14 are part of the AGC system.

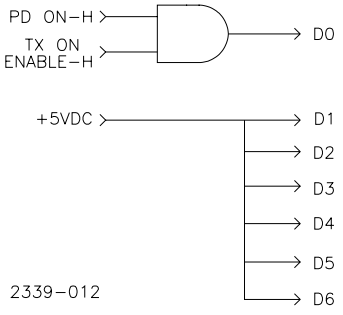

Figure E-1. L Drivers PAL

E.6.2 L DRIVERS PAL

Refer to Figure E-1, L DRIVERS PAL, for the following discussion.

NOTE

Many of the inputs to U7 are not being used by the PAL.

E.6.2.1 Predriver Control

Normally the PD_On input is logic high, and when the transmitter is turned on, the TX On Enable input at J3 will go logic high. The D0 output of the PAL will also be logic high and the Predriver is turned on.

Whenever the Predriver Select switch S1 is changed, the PD_On input will momentarily go logic low and mute the Predriver while the relays on the Driver Encoder are switched. The input will go back logic high and the Predriver will be turned on again.

When the transmitter is OFF, the TX On Enable will go logic low, and the Predriver is turned off.

E.6.2.2 Driver D1 - D6 Control

Whenever the +5VDC supply is present, the D1 through D6 outputs will be logic high. These Drivers will always be turned on.

E.6.3 R DRIVERS PAL

Refer to Figure E-2, R DRIVERS PAL, for the following discussion.

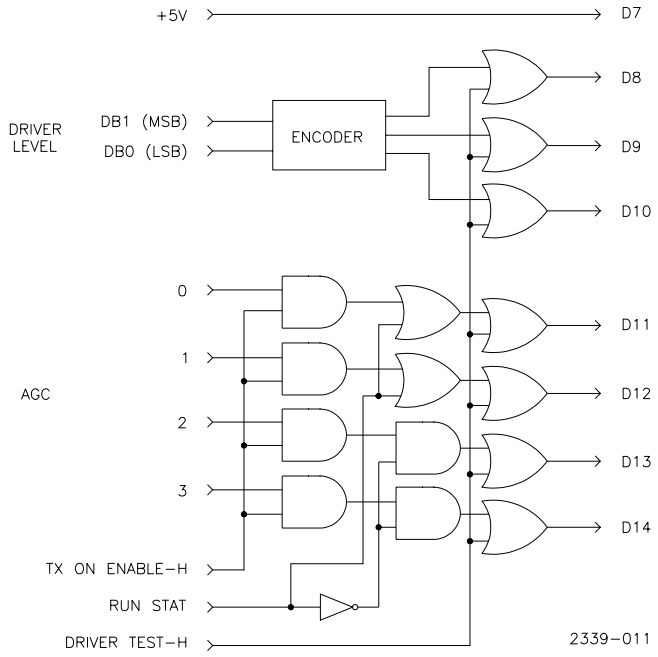

Figure E-2. R Drivers PAL

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E.6.3.1 Driver D7 Control

Whenever the +5VDC supply is present, the D7 output will be logic high. This Driver will always be turned on.

E.6.3.2 Driver D8 - D10 Control

Driver Level Inputs Bit 0 (LSB) and Bit 1 (MSB) from the Frequency Control Interface enter the board at J9. Both are connected to an Encoder inside the PAL and depending upon the input, control Drivers D8 - D10. When the output is a logic high, the Driver is turned on. The following chart lists the function of the encoder:

Inputs		Outputs			Drivers On (Outputs High)
B0	B1	D8	D9	D10	
0	0	0	0	0	0
1	0	1	0	0	D8
0	1	1	1	0	D8, D9
1	1	1	1	1	D8, D9, and D10

E.6.3.3 Driver D11 - D14 Control

These Drivers are controlled by the AGC 0 through AGC 3 inputs from the comparators. The TX On Enable and the Run Status inputs are also used in the control of these Drivers.

When the transmitter is first turned on, the TX On Enable input is logic high, and the Run Status input is logic high. At this point in the step-start sequence, Drivers D11 and D12 will be turned on by the OR gate, while D13 and D14 will be held off by the AND gate.

After the step-start sequence has energized the Run contactor, the Run Status input will go logic low. If any one of the AGC inputs goes logic high, the corresponding Driver output will also be logic high and turn on the appropriate Driver.

When the transmitter is OFF, the TX On Enable input will be logic low, and all Drivers will be turned off.

E.6.3.4 Driver Test

Turn on signals can be applied to all Drivers without turning on the transmitter. This feature is provided as an aid to troubleshooting and is accomplished through the use of Driver Test. When JP9 is in the 2-3 Test position, a logic high is supplied to the PAL and all outputs from the PAL should be logic high. All Driver Amplifier Driver outputs at J1 should be a negative voltage.

P1 is normally left in the 2-1 position and the TX On enable input is used for control of the Drivers.

E.6.4 Driver Amplifier Drivers

The Drivers U3 through U6 and U8 through U11 convert logic high or low PAL outputs to the proper voltages for each Driver.

E.6.4.1 Jumper Plugs

A jumper plug is in series with the input to each inverter, and can be used during troubleshooting and in emergency bypass operations.

If the jumper plug is removed and a logic high supplied to the input pin of the inverter, the Driver should be turned on.

If the jumper plug is removed and a logic low supplied to the input pin of the inverter, the Driver should be turned off.

Pull-down resistors on each input holds the input low if the gold jumper plug is removed.

E.6.4.2 Inverters

Each inverter output goes to a voltage divider, made up of a series resistor and a second resistor to the -5VDC supply. The junction of the resistors is the Driver RF Amplifier turn-on/turn- off control circuit's input.

When the input is low, the inverter output is connected to +5VDC. Due to the voltage divider action, the output to the Driver is about +2.2VDC and the Driver is turned OFF.

When the input is high, the inverter output is connected to ground. Due to the voltage divider action, the output to the Driver is about -1.4VDC and the Driver is turned ON.

Connectors J1 and J2 carry the turn on/off signals to the Driver Combiner Motherboard where it is distributed to each Driver Amplifier.

NOTE

For more detailed information on the inverter and voltage divider, refer to the Modulation Encoder section.

E.6.5 Predriver B Select

Predriver A is normally in operation. Should it be necessary, Predriver B can be selected. This is accomplished by either the Local Predriver Select switch or with a Remote Predriver B Select control input.

Either will generate a Predriver Mute, while the Predriver Select Relay on the Driver Combiner Motherboard switches between the Predrivers. The RF Mute is lifted after the relay has closed.

E.6.5.1 Predriver Relay Supply

The positive (+) inputs to the Predriver relays coils are supplied +15VDC at J8. The other sides (-) of the coils are returned to the board on the Predriver Relay On line.

E.6.5.2 Predriver Select Switch

Normally, S1 is in the Predriver A open position and the switch is open. The Predriver Relay Drive line will be +15VDC and the relays will de-energized.

If S1 is moved from the Predriver A to the Predriver B position, the Predriver relays will be energized through S1 and R51, selecting Predriver B. The current through the resistor will develop a positive voltage and charge C23 through the base/emitter of Q4. This will cause the collector of the transistor and the PD_ON input to the L DRIVERS PAL to be pulled logic low momentarily. The D0 output of the PAL will go low turning off the Predriver while the output is switched. When the capacitor is charged, the PD_ON input will go back to a logic high and turn on the Predriver again.

If S1 is moved from the Predriver B to the Predriver A position, the Predriver relays will be de-energized, selecting Predriver A. The PD Relay On line will be +15VDC and charge C24 through the base/emitter of Q5. This will cause the collector of the transistor and the PD_ON input to the L DRIVERS PAL to be pulled logic low momentarily. The D0 output of the PAL will go low turning off the Predriver while the output is switched. When

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the capacitor is charged, the PD_ON input will go back to a logic high and turn on the Predriver again.

E.6.5.3 Remote Predriver Select Transistor

Transistor Q3 is used as a switch that is in parallel with S5. When the Predriver Select - H input at J3 is logic high, Q3 will be turned on and Predriver B will be selected.

E.6.6 Drive Level Detector

An RF Sample from the RF Splitter board is applied to the Drive Level Detector input at J7. The transformer and components on its primary, simulate the input of an RF Amplifier. One of the transformer secondaries is connected to a rectifier and filter capacitor. This rectifier converts the RF signal to a dc voltage proportional to the RF drive level applied to all Big Step and Binary RF Amplifiers and can be measured at TP7 Drive.

E.6.7 Driver AGC

The RF drive level dc voltage from TP7 is connected to a buffer amplifier and to one input of a differential amplifier formed by U20. The other input of the differential amplifier is an adjustable Automatic Gain Control dc voltage set by R100. It is adjusted such that approximately 21Vp-p of RF drive is applied to all 160 RF Amplifiers over the entire frequency band. The output of the differential amplifier is connected to 4 comparators.

E.6.8 AGC Comparators

The RF drive level dc voltage from TP7 is connected to the (+) inputs of 4 comparators labeled AGC0 through AGC3. The (-) inputs of the comparators are connected to resistive voltage divider that supplies +2VDC, +3VDC, +4VDC, and +5VDC as the threshold inputs.

When the output of the differential amplifier goes more positive than the threshold of each comparator, the output of the comparator will go logic high.

When the output of the differential amplifier goes less positive than the threshold of each comparator, the output of the comparator will go logic low.

These 4 outputs are used by the R DRIVERS PAL to control the D11 through D14 Driver Amplifiers.

E.6.9 Drive Level Fault Sensing

Drive Level Fault Sensing is used to protect the transmitter under two fault conditions.

E.6.9.1 High Drive Comparator

The RF drive level dc voltage from TP7 is also connected to the to the negative (-) input of the High Drive Fault comparator. A reference voltage is set, on the positive (+) input of the comparator at TP5 High Drive, with the High Drive Adjust control R84. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic high.

If the RF drive level dc voltage increases above the reference voltage, the comparator output will go logic low. This sends a High Drive Fault - Low to the Controller at J3, which is an Overload fault.

The High_D output of the other comparator is not being used in this configuration.

E.6.9.2 Low Drive Comparator

This RF drive level dc voltage from TP7 is sent to the positive (+) input of the Low Drive Fault comparator. A reference voltage is set, on the negative (-) input of the comparator at TP6 Low Drive, by the Low Drive Adjust R86. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic high.

If the RF drive level dc voltage drops below the reference voltage, the comparator output will go logic low. A Low Drive Fault - Low will be sent to the Controller at J3, which is an Overload fault.

The Low_D output of the other comparator is not being used in this configuration.

E.6.9.3 Low Drive Comparator Threshold

Transistor Q6 is used to disable the Low Drive Fault comparator while the transmitter is OFF.

When the transmitter is OFF, the TX_ON_EN input is logic low and anode of CR3 is pulled logic high by the inverter. Capacitor C36 charges from ground through resistors and the transistor is turned on. The collector of the transistor and the (-) input of the comparator is pulled logic low. This disables the Low Drive Fault sensing.

When the transmitter is turned on, the TX_ON_EN line will be logic low. This will reverse bias the diode and allow the capacitor to discharge through the base of the transistor. The transistor slowly turns off, allowing the reference voltage to rise on (-) input of the comparator and enables the Low Drive fault comparator. This delay allows time for the RF drive system to reach normal operating parameters during the step-start sequence.

E.6.10 Driver Level Output

The RF drive level dc voltage from TP7 is also connected to a Drive Sample Buffer and eventually becomes the Relative Drive Level reading on the front panel multimeter and the Driver Sample on the Frequency Control board Multimeter.

E.6.11 Buffer Level Sensing

Separate rectified RF output samples from Buffer Amplifier A and B from the Driver Combiner Motherboard are applied to the fault sensing circuit inputs at J8.

Both Buffer Amplifiers are normally in operation. The Buffer Fault Sensing circuit however, will monitor only the Buffer Amplifier being used. This is determined by the Predriver Relay Drive signal.

E.6.11.1 Buffer A

Normally Predriver A is selected for operation and +15VDC is present on the Predriver Relay Drive (PD_Relay_On) output at J8. This +15VDC provides a reference voltage at the (-) input of Buffer A fault comparator U15 through a resistive voltage divider.

The RF level dc voltage sample from Buffer A output supplies a positive voltage at the (+) input of the comparator at TP2 Buffer

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A. Normally the voltage at the positive (+) input will be higher than the voltage at the negative (-) terminal, and the output of the comparator will be logic high.

If this dc voltage drops below the reference voltage, the output of the comparator will go logic low and a Buffer Fault - L will be sent to the Controller at J3. An RF MUTE will be applied to the transmitter.

The same +15VDC disables the Buffer B Fault sensor by pulling the (+) input of the comparator logic high through CR1.

E.6.11.2 Buffer B

If Predriver B is selected, the Predriver Relay Drive line will be 0VDC. This will disable Buffer A Fault sensor by lowering the reference voltage on the (-) input to a logic low. With the Predriver Relay Drive line logic low, the diode is reverse biased and Buffer Amplifier B output is monitored at TP1 Buffer B.

If the Buffer Amplifier sample drops below the reference voltage, a Buffer Fault - L will be sent to the Controller and an RF Mute will be applied to the transmitter.

E.6.12 Predriver Level Sensing

A rectified RF level dc voltage sample from the active Predriver (A or B) is taken from the Driver Combiner Motherboard. This dc voltage at TP3 Predriver is applied to the (+) input of a comparator. The (-) input is a fixed voltage from a resistive voltage divider.

Should the active Predriver sample drop below the reference, a Predriver Fault will be sent to the Controller and an RF Mute will be applied to the transmitter.

E.6.13 A/D Phasing

A sample of the RF drive to all 160 RF Amplifier is also used as a Start Encode pulse squarewave for the A/D Converter board. Depending upon the frequency of operation, the signal will either be at the carrier or 1/2 the carrier frequency.

E.6.14 RF Drive Input Conditioning

The RF drive sample from J21 on the RF Splitter board is connected to the Driver Encoder at J7. An input resistor provides a 330-Ohm input impedance. The RF is clamped to TTL levels by the diodes CR5 and CR10. The RF squarewave is inverted by U13-4 and connected to U18-6.

E.6.15 Digital Phase Adjustment

U18 is a programmable digital delay line that will change the phase lag delay of a TTL input signal in discreet nS steps depending on the Bit 0 through Bit 5 inputs.

Normally the phase shifted output at U18-2 passes through JP8 1-2 and is connected to the A/D Frequency Switch. If a complete 180 degree phase shift is required, the relay that is activated by the bit 5 input will energize and the output will be shifted 180 degrees.

E.6.16 A/D Frequency Switch

The phase shifted carrier frequency squarewave output at JP8-2 is connected to a divide by 2 circuit and a tri-state buffer.

E.6.16.1 Divider

The Q output of the frequency divider U21 will be 1/2 the carrier frequency and is connected to a tri-state buffer.

E.6.16.2 Tri-State Buffer Switch

The A/D Frequency Bit 0 input from the Frequency Control Interface Board enters the board at J9 and is connected to tri-state buffer U22.

When the A/D Frequency Bit 0 from the frequency Interface board at J9 is logic low, JP8-2 is connected to the output at TP4 A/D Phase via U22-9. Inverter U13 supplies the other half of U22 with a logic high, and the output at U22-18 is disconnected.

When Bit 0 is logic high, U21-5 is connected to the output at TP4 A/D Phase via U22-18 and the output at U22-9 is disconnected.

JP10 is not being used on this configuration.

E.6.17 Output A/D Sample

The output at TP4 A/D Phase signal, that is either at carrier or 1/2 carrier frequency, is connected to the Transmitter Interface and then passed on to the A/D Converter board.

E.6.18 A/D Phase Data Input

The BIT0 (LSB) through BIT5 (MSB) enter the board on J6; pins 11, 9, 7, 5, 3 and 1. Bits 0 through 4 are applied to U18. Bit5 is applied to Q1 which acts as a relay driver for K1. K1 contacts 13-9 (energized) is used to select an inverted or non-inverted output from U18.

E.6.19 Band Indicators

A 10 segment Band Indicator LED is used to give a visual indication of the A/D Phase Data Input, Driver Level Data Input, and FC or 1/2 FC operation. If the BIT input is a logic high, an inverter applies a logic low to the cathode of the appropriate LED, illuminating the indicator RED. The operational tri-state buffer provides +5VDC for the appropriate division indicator.

E.6.20 Power Supply Temperature Sensing

The temperature sensor function is provided by four 10mV/degree C precision temperature sensors mounted on the heat sinks of the RF Amplifier Power Supply rectifiers.

E.6.20.1 Power Supply Temperature Inputs

Each sensor is supplied +5VDC & ground and the voltages from the sensors enter the board on J4. The voltages are amplified by a factor of 10 by operational amplifier U25.

E.6.20.2 Power Supply Fault Comparators

Voltage divider R118, R120, and R123 provides a reference voltage at the positive (+) input terminals of comparators U26 and U27.

Since the operation of all four sensor circuits is identical, only one circuit will be discussed.

As the temperature of the sensor for Power Supply A at J4-1 starts to increase, the voltage at TP11, the negative (-) inputs of U27-6 and U26-6 will also start to increase. Due to the reference voltage divider action, the output of U27-1 will go low at a temperature of 66 degrees C and the output of U26-1 at 83 degrees C.

WARNING: Disconnect primary power prior to servicing.

When U27-1 goes low, DS5 Power Supply A Overtemp will be illuminated RED, indicating a temperature warning. Comparator U2-1 will go high, turning on Q7 which sends a Power Supply Temp-L signal to the Controller. This will initiate a transmitter power FOLDBACK. Every four minutes that this line remains low, a further reduction in power will occur until the transmitter is turned off.

If the sensor temperature continues to rise, the output of U26-1 will go low and will provide a continuous logic low Power Supply Temp Fault-L. This action will cause the transmitter to turn OFF.

E.6.21 Drive Sample Buffers

Operational amplifier U19-1 takes the Driver Level dc voltage from the Drive Level Detectors and buffers the signal. The Relative Drive Level output at J3 is eventually connected to the front panel Relative RF Drive multimeter position. The samples at J9 are eventually connected to the TUNE multimeter on the Frequency Control board.

E.6.22 Module/Cable Interlock Function

Refer to Figure E-3, Driver Cable Interlock Detection Circuit for the following discussion.

E.6.22.1 Closed Loop

The cable interlock function is provided by two sets of series connections. When all the Drivers and Driver Encoder cables are properly installed, a closed circuit is established from J2-20 to J2-9 via the Predriver & Drivers D1 through D6 and from J1-19 to J1-10 via Drivers D7 through D14. Since both interlock circuits are the same, only one will be discussed.

E.6.22.2 Voltage Divider

Due to the voltage divider action of R177, R178, R5(7,8), R4(5,6), R5(5,6) and R4(3,4), the voltage at the positive (+) input of comparator will be greater than the voltage at the negative (-) input. Under these conditions, the output of the comparator will be logic high and DS8 will be off.

E.6.22.3 Open Loop

When an interlock connection between J2-20 and J2-9 is opened, by removing a Driver Encoder cable or unplugging a Driver, the voltage at the positive (+) input of the comparator will be lower than the voltage at the negative (-) terminal due to the additional voltage drop provided by CR20.

Under these conditions, the output of the comparator will go logic low. DS8 Cable Interlock will be illuminated RED and transistor Q9 will turn on, pulling the voltage at J3-9 low.

This will cause the transmitter to turn OFF, and the Encoder Module/Cable Interlock LED on the Control front panel will be illuminated RED.

E.6.23 Power Supplies

DC supply inputs to the board are +22VDC, +8VDC, and -8VDC, from the low voltage power supply. Each input is fused, with 2A fuses F1, F2 and F3, and regulated to +15VDC, +5VDC, and -5VDC using regulators U29, U30, and U31. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The output of the regulators are transient protected by zeners CR14, CR15, and CR18.

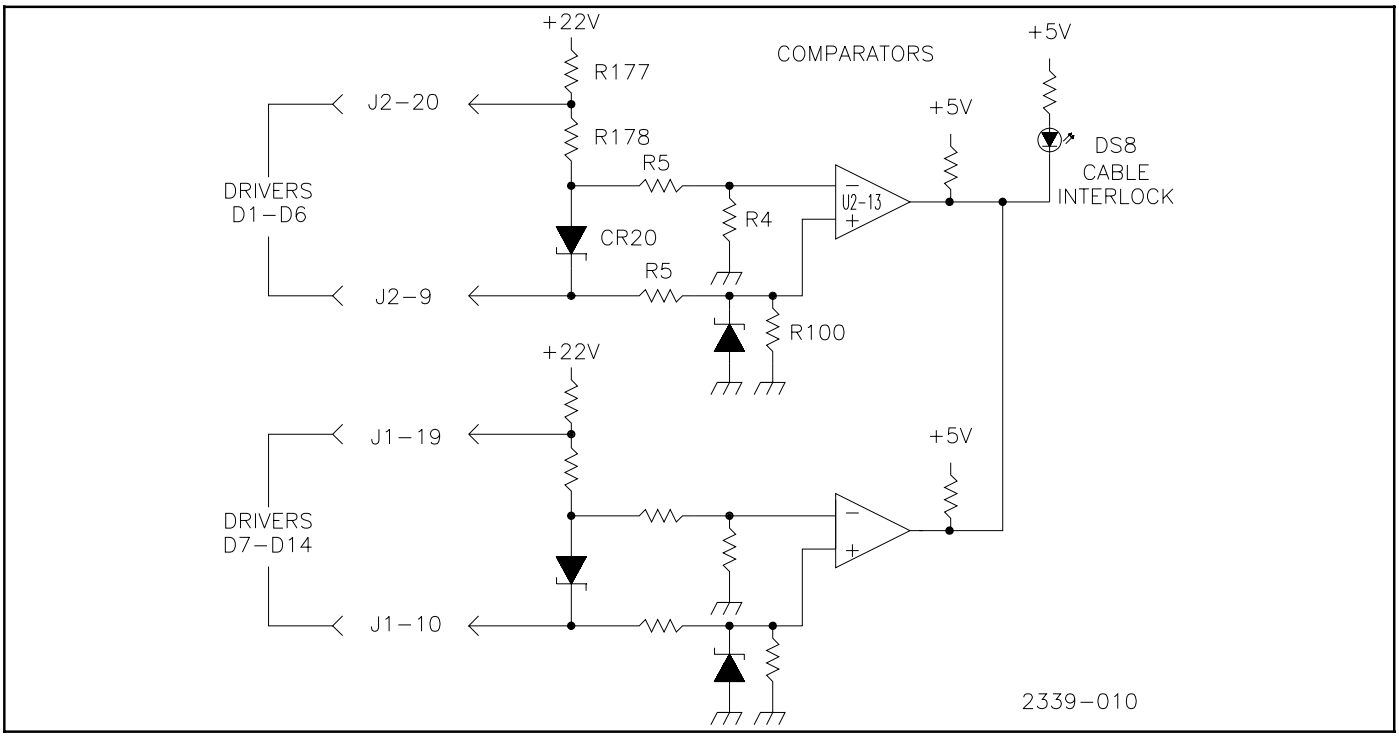


Figure E-3. Driver Cable Interlock Detection Circuit

WARNING: Disconnect primary power prior to servicing.

E.6.23.1 Regulator Status

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +22VDC supply goes to CR9 and CR11 and +8VDC goes through CR12 to a 5 Volt regulator, U33. This +5 Volts is designated +5VB and can be measured at TP19.

The +5VB is used as a reference to inputs of comparator U32 through a series voltage divider network. Each supply is connected to a voltage divider and then connected to the other inputs of the comparator. With the non-inverting inputs more positive than the inverting inputs the comparator output is a logic high. This is the NORMAL condition with no faults.

If one of the regulated supplies fails or drops low by more than 20%, the corresponding comparator output will go logic low. DS7 Supply Fault will be illuminated RED and transistor Q8 will turn on, pulling the voltage at J3-3 low.

This will cause the transmitter to turn OFF, and the Encoder Supply Fault LED on the Control front panel will be illuminated RED.

E.7 Troubleshooting

Circuitry on this board can be classified into these major areas:

a. Power Supply
b. Fault Sensing
c. Driver Control
d. A/D Phasing and
e. Cable Interlock.

Refer to the corresponding section for the area being addressed.

E.7.1 Power Supply

If an Encoder supply fault is displayed on the Control front panel, and with only the low voltage on, check the LED indicators on the Driver Encoder:

a. DS1 (+5V)
b. DS2 (-5V)
c. DS3 (+15V)

Each of these LED indicators should be Lit if the individual supplies are operating normally.

a. If DS7 is illuminated RED:
b. Use the Multimeter to measure the +15VDC, +5VDC, and -5VDC power supplies.
c. If either supply has been reduced by 20% or more:
   1. Check the input fuse and replace if necessary.
   2. If fuse is not open, measure input TP for the unregulated voltage.
   3. If the unregulated input is correct, replace the regulator.
d. If all supplies measure correct:
   1. Check TP10 for +5VDC and replace U11 if necessary.
   2. If TP10 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

E.7.2 Fault Sensing

E.7.2.1 High Drive Sensing

With the transmitter OFF, and only the Low Voltage ON, begin troubleshooting as follows:

a. Measure the output J3-11 on this board. A logic low indicates a fault.
   1. If this point is low, unplug J7 from the board and recheck the output.
   2. If this point goes to a logic high, a fault may exist in the wiring, Transmitter Interface, or Controller.
   3. If the output remains low, check the voltage on TP5. If it is more positive than TP7, (TP7 should read 0 Volts with the transmitter off) replace U17.
b. If the comparator checks okay, then the drive sample could be the problem.
   1. Check the RF Drive Splitter RF Sample level across the input at J7 during the step-start sequence.
   2. If it is higher than normal, inspect the transformer assembly and associated circuitry on the Driver Encoder and the sample connection and cables coming to the Driver Encoder. Refer to the overall wiring diagram as needed.

E.7.2.2 Low Drive Sensing

With the transmitter OFF, and only the Low Voltage ON, begin troubleshooting as follows:

a. Measure the output at J3 on this board. A logic low indicates a fault.
   1. If this point goes to a logic High, then a fault exists in the wiring, Transmitter Interface, or Controller.
b. If the output is low, the following can be checked during the step-start sequence.
   1. Compare the voltages at TP7 and TP6. TP7 should be greater than TP6.
   2. If it is, and the output is still logic low, replace U17.
c. If the comparator checks okay, then the drive sample could be the problem.
   1. Check the RF Drive Splitter RF Sample level across the input at J7 during the step-start sequence.
   2. If it is lower than normal, inspect the transformer assembly and associated circuitry on the Driver Encoder and the sample connection and cables coming to the Driver Encoder. Refer to the overall wiring diagram as needed.

E.7.2.3 Power Supply Temperature Fault

Note

Troubleshooting the Temperature indicator will require that the fault be active at the time of troubleshooting. This procedure assumes that the fault is active and cannot be reset from the Control front panel display.

WARNING: Disconnect primary power prior to servicing.

Start troubleshooting by checking to see which Power Supply Indicator DS5 or DS6 is illuminated.

E.7.2.4 Power Supply A Overtemp

If Power Supply Overtemp A indicator is illuminated, proceed as follows,

a. Measure the voltage on TP11. Multiply this reading by 10 to obtain a temperature reading in degrees Centigrade.
b. If this appears high or abnormal compared to the suspected actual temperature of the rectifier heatsinks, the sensor or U3 may be faulty.
    1. The voltage on TP11 should be 10 times greater than the voltage on the input amplifier.
    2. If the voltage is at the proper level, replace the sensor.
    3. If not, replace the amplifier and or associated circuitry. If the reading for TP11 seems normal, repeat the above procedure at TP12.
c. If TP11 and TP12 appear normal, compared to the suspected rectifier heatsinks, troubleshoot the fault comparators. The outputs should be a logic low during a fault condition.
    1. Check to see if the voltage at the (+) input is more positive than the (-) input.
    2. If it is, replace the comparator.

E.7.2.5 No Indicator Illuminated

a. If no indicator is lit and the transmitter is on with foldback active, check U2 and the transistor Q7 for proper operation.

E.7.2.6 Power Supply B Overtemp

If Power Supply Overtemp B indicator is illuminated, use the same procedure as above using the corresponding test points.

E.7.2.7 Buffer Fault Sensing

If a Buffer Fault indicator is illuminated on the Control front panel and the transmitter may be turned on with an RF MUTE applied, start troubleshooting as follows.

a. If the Buffer Fault output is logic low at J3, measure the reference voltages when Predriver A is selected.
    1. U15-4 should be +2.5VDC and TP1 should be +4.3VDC.
    2. If not present, check for a defective CR1 or CR2.
b. Check for the Buffer sample.
    1. Measure TP1 and TP2 for a voltage greater than the previously measured reference voltage.
    2. If the sample is not greater than the reference, check for a failed U1, an open cable, or a fault on the Driver Combiner Motherboard. Refer to the overall wiring diagram and the Driver Combiner Section as needed.
    3. If the sample is greater than the reference, replace the comparator.
c. If the Buffer Fault output at J3 is a logic high, refer to the overall wiring diagram, Transmitter Interface, and the Controller schematics to determine the cause of the logic low.

E.7.2.8 Predriver Fault Sensing

If a Predriver Fault indicator is illuminated on the Control front panel and the transmitter may be turned on with an RF MUTE applied, start troubleshooting as follows:

a. Check the Predriver Fault output at J3 for a logic low.
b. If low, check the reference voltage on the (-) input of the comparator, should be 2VDC.
    1. If the voltage is less than 2VDC, remove the comparator and re-check.
c. Check the Predriver sample.
    1. If the voltage on TP3 is less than the reference, check for a failed U1, an open cable, or a fault on the Driver Combiner Motherboard. Refer to the overall wiring diagram and the Driver Combiner Section as needed.
    2. If the sample is greater than the reference, replace the comparator.
d. If the Predriver Fault output at J3 is logic high, refer to the overall wiring diagram, Transmitter Interface, and the Controller schematics to determine the cause of the logic low.

E.7.3 Driver Control

There are two types of driver control present on the Driver Encoder Board:

a. Predriver Select
b. Driver Turn On

Refer to the corresponding section below for problem being addressed.

E.7.3.1 Predriver Select

If the Predriver cannot be switched on when S1 is toggled, begin troubleshooting as follows:

a. Check for +15VDC on the collector of Q3 when S1 is in the Predriver A position.
    1. If missing, check J8-9 on this board for +15VDC.
    2. If J8-9 has +15VDC refer to the overall wiring diagram and Driver Combiner Motherboard schematic to trace where the +15VDC is being lost. J8-9 supplies +15VDC to the Predriver Select relays on the Driver Combiner Motherboard, while J8-7 is the return line back to the Driver Encoder.
b. If Q3 has +15VDC present, then switch to the Predriver B position and check to see that the collector has gone logic low.
    1. If not, the switch could be defective or R51 could be open.
c. If the above circuits and components check good, the Predriver Select relay on the Driver Combiner may have failed. Refer to the Driver Combiner Troubleshooting Section to continue.

E.7.3.2 Predriver and Drivers D1 - D6 Will Not Turn On

a. If the Predriver is not being turned on, check the D0 output of the PAL for a logic high, when JP9 is in the TEST position.

WARNING: Disconnect primary power prior to servicing.

1. If logic low, check U7-2. If also logic low check transistors and capacitors connected to the input.
2. If logic high, replace the PAL.

b. If D0 is a logic high, then check the output at J1 for a -1.4VDC.
1. If J1 is +2.2VDC, replace the inverter driver.

c. If Drivers D1 through D6 are not being turned on, check the D1 thorough D6 outputs of the PAL for a logic high.
1. If any outputs are logic low, replace the PAL.

d. If D0 is a logic high, then check the output at J1 for a -1.4VDC.
1. If J1 is +2.2VDC, replace the inverter driver.

E.7.3.3 Drivers D7 - D14 Will Not Turn On

If any or all of the Drivers will not turn on, begin troubleshooting as follows.

a. Place the Driver Test Jumper JP9 in the TEST position.

b. Measure the D7 through D14 outputs of the PAL.
1. If the outputs are not all logic high, replace the PAL.

c. If the outputs are all high, measure the outputs of the inverter.
1. All outputs at J1 should be -1.4VDC, if any one is not, replace the inverter driver.
2. If the negative voltages are present, inspect connector J2 and refer to the Driver Combiner Troubleshooting section to continue.

d. Measure the AGC inputs to the PAL. With the transmitter OFF, all inputs should be logic high. If they are not, replace U14 and U20.

e. Return the Driver Test Jumper back to the Normal position.

f. Measure the TX On Enable during the step-start sequence.
1. This input at J3 should go logic high when the transmitter is turned on. If it does not, refer to the overall wiring diagram and the Transmitter Interface Section as needed.

E.7.3.4 Cable Interlock

If DS8 is illuminated RED on the Driver Encoder, there are three basic possibilities,

a. Start by ensuring that the RF modules and cables are firmly inserted into the Driver Encoder and Driver Combiner Motherboard.

b. If the fault remains use a clip lead to jumper the cathode of CR20 to R177 (J2-20 to J2-9).
1. If the LED extinguishes, refer to the Overall wiring diagram and the Driver Combiner section to trace the open.

c. If the LED is still illuminated, use another clip lead and jumper R180 to the cathode of CR25 (J1-19 and J1-10).
1. If DS7 goes out refer to the Overall wiring diagram and the Driver Combiner Section to trace the open.

d. If the LED remains illuminated when both clip leads are in place, measure the voltages at the (+) input and (-) inputs to the comparators.
1. If the (+) input voltage is greater than the (-) input, replace the comparator.
2. If the (+) input voltage is less than the (-) input, check the resistors and diodes.

e. If the output at J3 is logic high, refer to the overall wiring diagram and the Transmitter Interface schematic section to locate the fault.

E.7.4 A/D Phasing

a. Check for a carrier frequency or 1/2 carrier frequency squarewave signal at TP4 of 5Vp-p when the transmitter is on.
1. If not present, check JP8-2. If a carrier frequency signal is present check the divider and the tri-state buffer.

b. If a carrier frequency signal is not present JP8-2, check for a carrier frequency squarewave signal at the input of U18 of 0.7V to 4.3 Volts peak to peak when the transmitter is on. If a signal is present, replace U18.
1. If not present at the U18 input, check the input circuitry. There should be an RF signal detected across the input resistor.
2. If there is no signal present, refer to the overall wiring diagram to find the loss of signal from the RF Splitter.

c. If the correct output at TP4 is present, refer to the overall wiring diagram and the A/D Converter Troubleshooting section to continue.

E.8 Removal and Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting screws. The cable connectors are keyed for identification during replacement. When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches on the new board are set to the same position as corresponding ones on the original board.

E.9 Alignments

E.9.1 High & Low Drive Thresholds

Measure the voltage on TP5, High Drive, and adjust R5 to the same as the recorded value from the factory test data sheet.

Measure the voltage on TP6, Low Drive with the transmitter on, and adjust R6 to the same as the recorded value from the factory test data sheet.

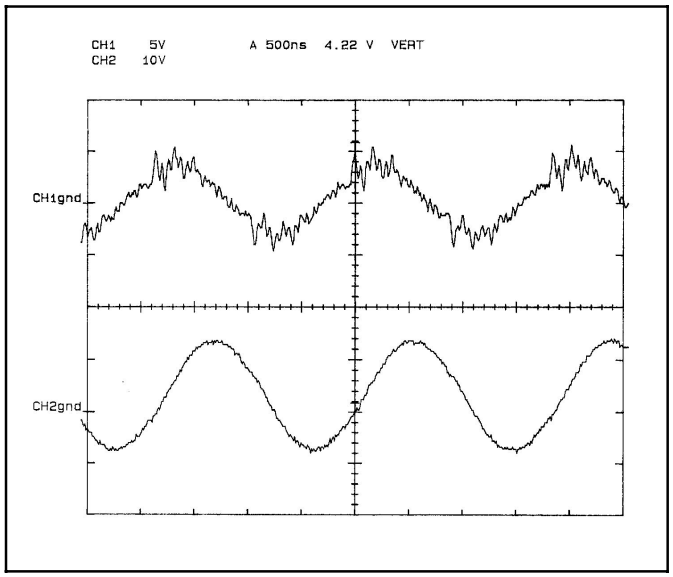
NOTE

If the transmitter turns OFF, due to a Low Drive Fault, turn R6 CW clock-wise 1 turn and repeat the adjustment.

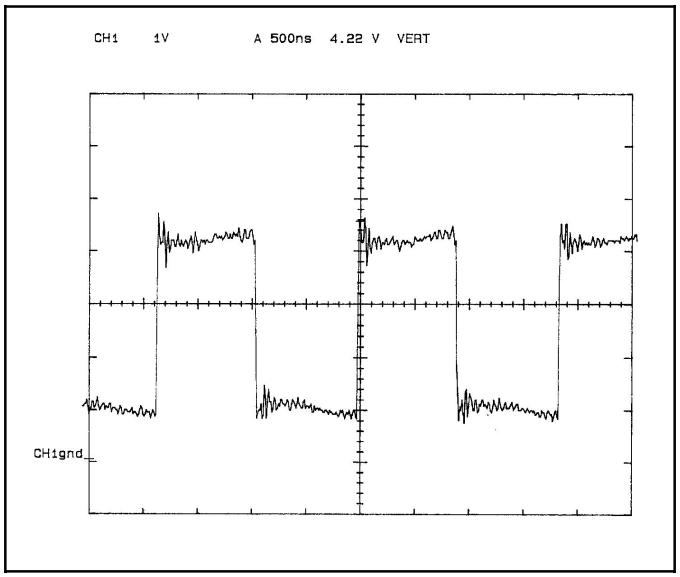
E.9.2 AGC

Turn on the transmitter and observe the Relative RF Drive on the front panel meter. Adjust R100 for the same reading as obtained from the factory test data sheet for the specified frequency.

WARNING: Disconnect primary power prior to servicing.

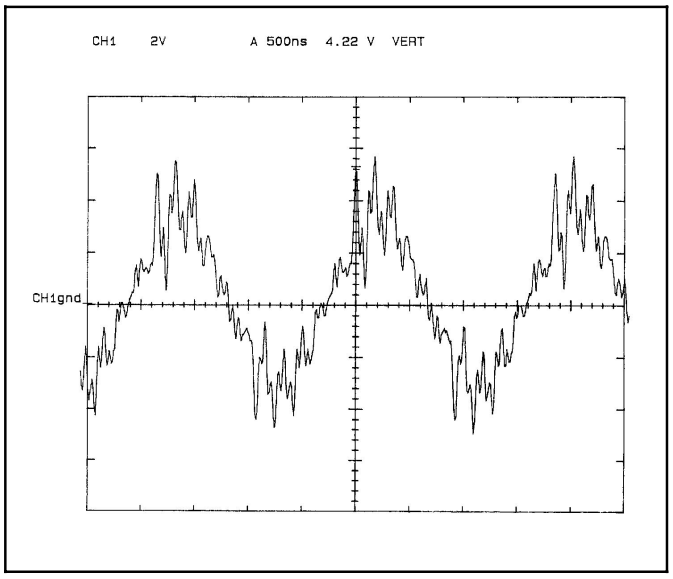


CH1 J7-3
CH2 TP4

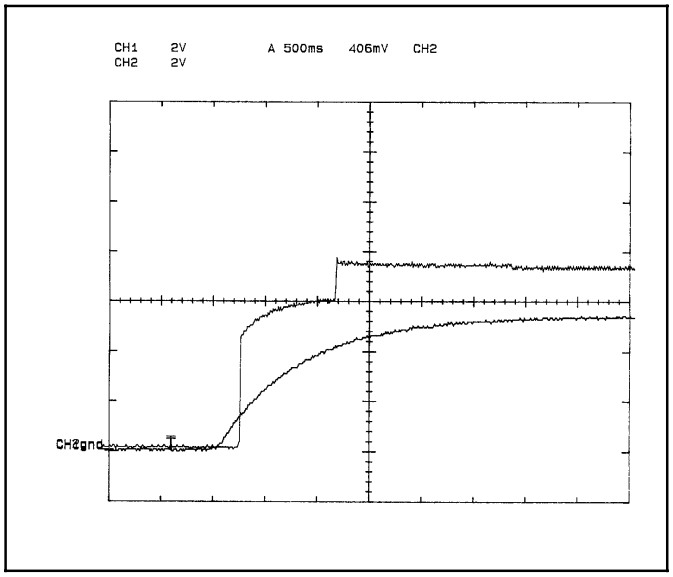


J6-1

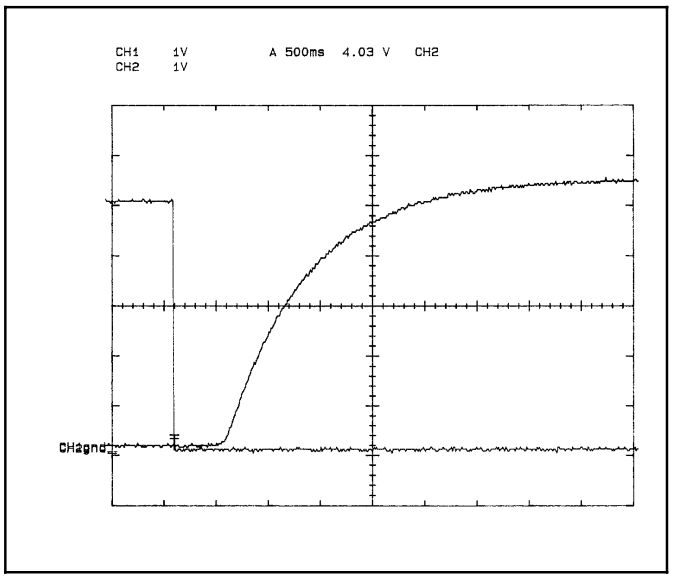
WARNING: Disconnect primary power prior to servicing.



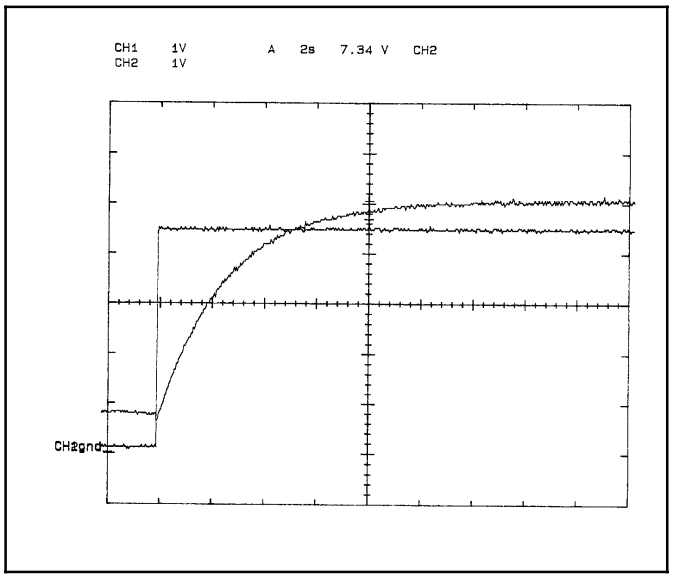
J7-5



Upper Trace - TP7
Lower Trace - TP6
NOTE - Taken During Turn-On Sequence



High to Low Signal - Anode of CR3
Low to High Ramp Signal - TP6
NOTE - Taken During Turn-On Sequence



Low to High Signal - J3-1
Low to High Ramp Signal - JP9-1
NOTE - Taken During Turn-On Sequence

WARNING: Disconnect primary power prior to servicing.

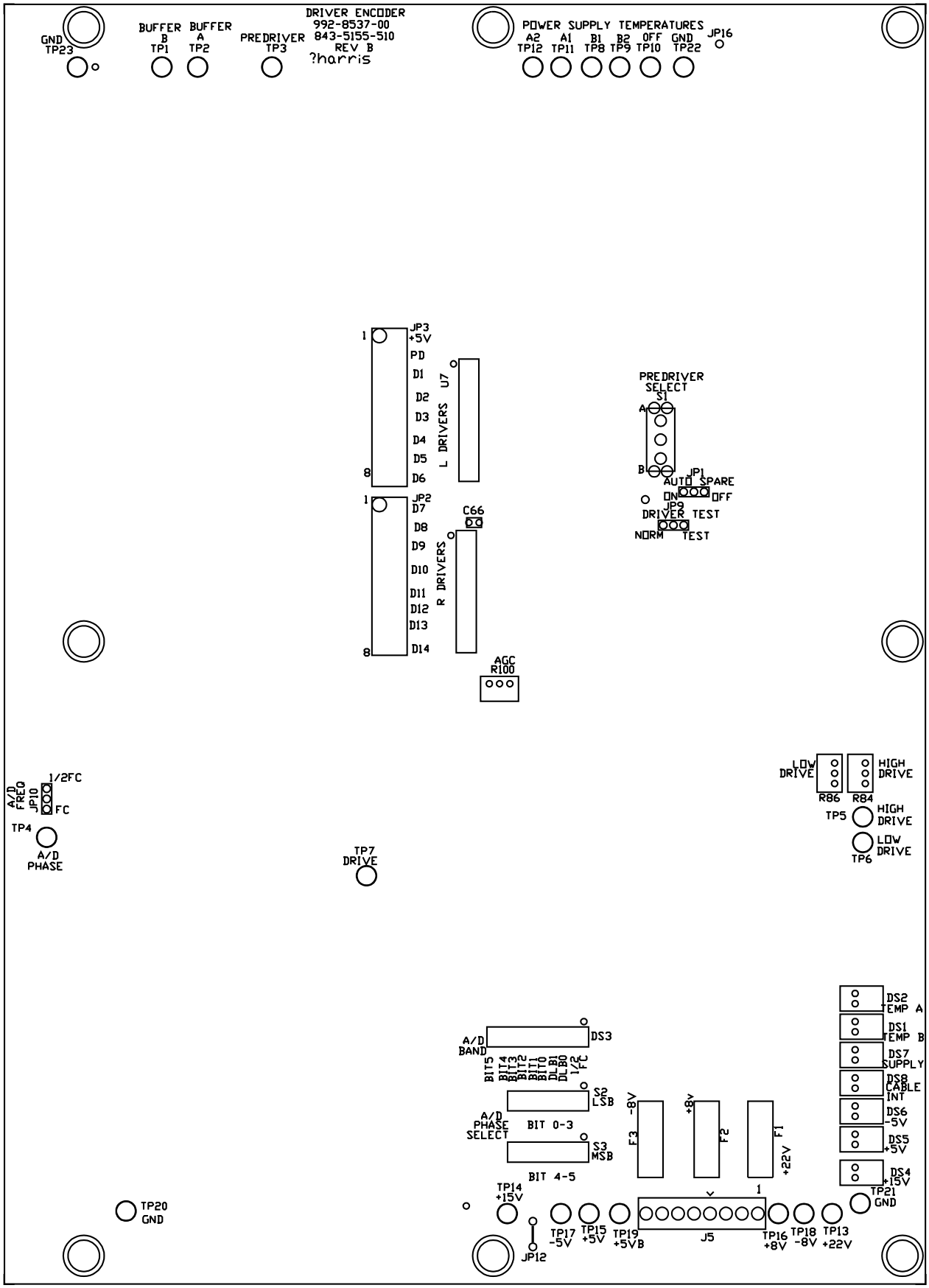


Figure E-4. Driver Encoder Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

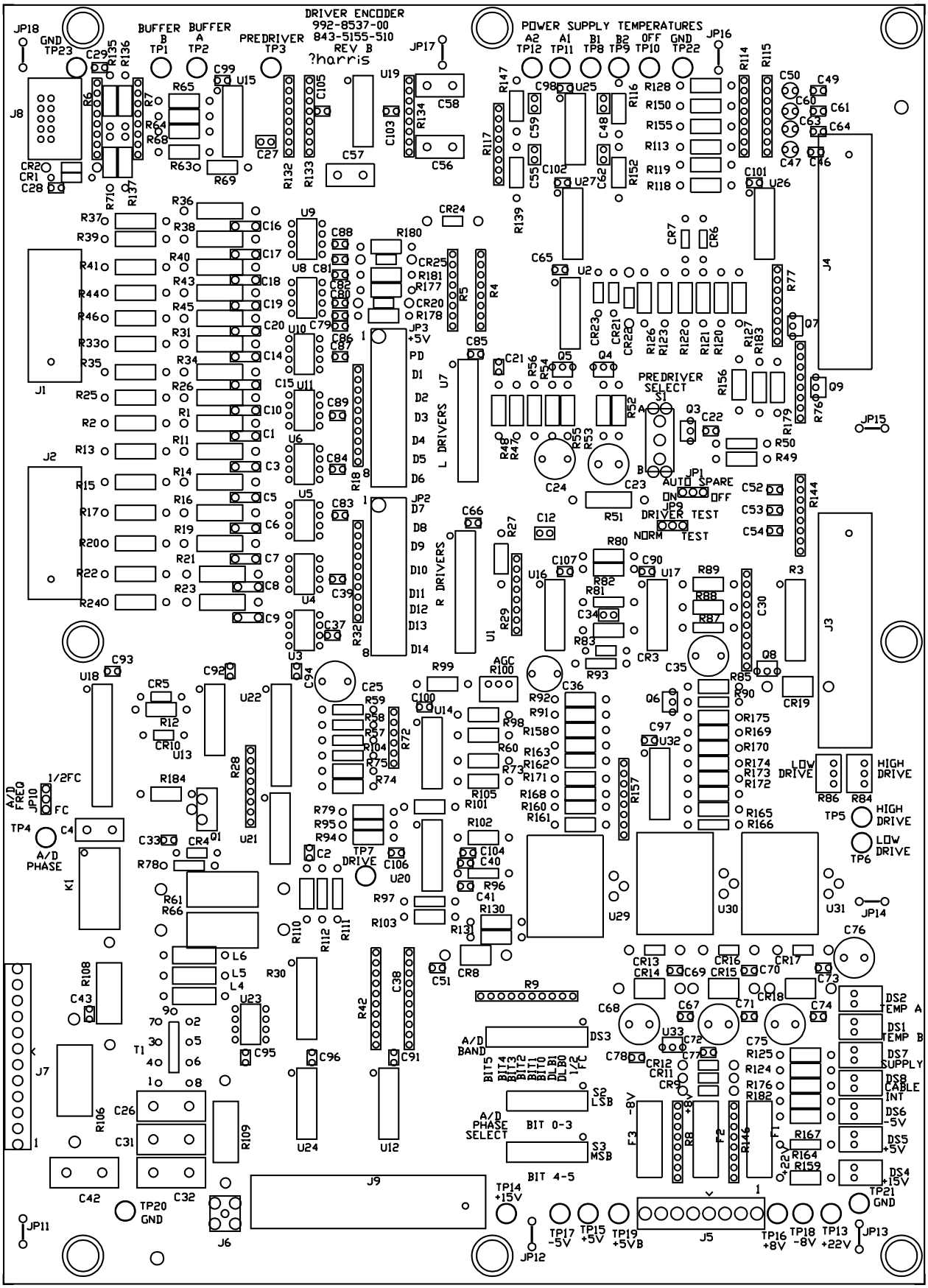


Figure E-5. Driver Encoder Component Locator

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

F.1 Introduction

This section describes the Main and Binary RF Combiner Motherboards. Topics include function, location, detailed circuit description, and removal/replacement.

NOTE: For more information about the RF Combiner, refer to the Overall System Theory Section.

NOTE: Parts List for this board is covered in Section VII, and RF Amplifiers are described in Section G.

F.2 Function

The purpose of the Main RF Combiner Motherboards is to provide the input/output connections for the Big Step RF Amplifiers.

The purpose of the Binary RF Combiner Motherboard is to provide the input/output connections for 12 Big Step RF Amplifiers, and 4 Binary RF Amplifiers.

F.3 Location

The A10 Binary RF Combiner Motherboard and the A11 Main RF Combiner Motherboard are located in the right compartment. (SEE VIEW 15).

The A12 through A15 Main RF Combiner Motherboards are located in the center compartment. (SEE VIEW 16).

The A16 through A19 Main RF Combiner Motherboards are located in the left compartment. (SEE VIEW 17).

F.4 Detailed Circuit Description - Main RF Combiner Motherboard

Refer to the Main Combiner Motherboard Schematic Diagram (drawing 839-7930-002) for the following description.

Each Main RF Combiner Motherboard contains combiner transformer toroids (T1 through T16 on each board) and a printed circuit board socket for 16 RF Amplifiers. The RF Amplifiers are mounted in two rows of 8 connectors.

F.4.1 Big Step RF Amplifier Connections - J1 through J16

F.4.1.1 RF Input

The RF drive inputs are obtained from the A6 RF Splitter secondary and the RF drive cables that are connected to J17 through J24. There is a separate RF drive cable for each half-quad, so there are two separate RF drive cables for each amplifier. All RF drive coaxial cables are the same length, so all RF drive signals are in phase. Each RF Amplifier is provided two equal amplitude and phase RF drive inputs at pins 49 and 53 of each RF Driver connector.

F.4.1.2 Power Supply

Four fused +230VDC lines from the RF Amp Power Supply enters the Main RF Combiner Motherboard at E1 through E4. It is connected to each RF Amplifier connector at pin 23 and 29, and can not be adjusted.

F.4.1.3 RF Output

Each RF Amplifier output is connected to one of the combiner toriods (T1 through T16) at pins 1 and 7. Each of the toroids has a turns ratio of 16:1, sixteen turns for the primary winding and one turn for the secondary. The Efficiency Coil boards plug into P1 through P8 on the Main RF Combiner Motherboard and their taps are frequency determined.

F.4.1.4 Modulation Encoder Connections - J25 through J28

F.4.1.4.1 Turn-On Control Signals

On each of the four Modulation Encoder connectors, pins 1, 3, 5, and 7 are connected to pin 45 on four RF Amplifier connectors. When the voltage is -2VDC on a pin, the RF Amplifier is turned on.

F.4.1.4.2 Cable Interlock

When an amplifier is properly inserted a connection is made between pins 35/36 and pins 37/38 on the amplifier connector. On each of the four Modulation Encoder connectors, pin 9 will loop- through connecting traces/amplifiers/connectors and return to pin 10 with very low resistance. If an amplifier is disconnected, pin 9 and pin 10 will be an open circuit.

F.5 Detailed Circuit Description - Binary RF Combiner Motherboard

Refer to the Binary RF Combiner Motherboard Schematic Diagram (drawing 839-7930-003) for the following description.

The Binary RF Combiner Motherboard is similar to the Main Combiner Motherboard, with some additional components and differences.

F.5.1 Binary RF Amplifier Connections J1 through J4

F.5.1.1 Power Supply

The B9 1/2 Step and B10 1/4 Step operate from +115VDC that enters at E5. The B11 1/8 Step and B12 1/16 Step operate from +60VDC that enters at E1.

NOTE: +230VDC is connected to E2 and loops through E7/E8 and E9/E10 to supply the other four RF Amplifiers.

F.5.1.2 RF Output

The Binary Steps employ tapped transformer primary windings for fine adjustments. The tap positions depend on operating frequency and are selected with P30, P31, P32, and P33.

WARNING: Disconnect primary power prior to servicing.

F.6 Troubleshooting

Troubleshooting on the RF Combiner Motherboards consists essentially of visual inspection. Possible problem areas include:

a. Inspect connectors carefully, including removing RF Amplifiers if necessary to inspect pc board edge connectors.

b. Physically check connectors; plugs should be properly inserted into jacks or sockets.

1. Connectors loose.
2. Connector damage.

NOTE

Replacement edge connector sockets will have to be soldered in place.

c. Damage to printed circuit traces.

d. Cracked ferrite toroid cores.

1. The shield over the combiner must be removed to check combiner transformer cores. (If transformers must be replaced, be certain that the replacement has the same number of turns of wire as the original).
2. Possible dirt build up around toroids and combiner pipe after several years of operation and unfiltered air.

e. Loose taps, or incorrectly set taps on air-core inductors L1 through L16.

f. Loose connections where combiner rod sections join.

g. Failed electrolytic capacitors, used in the RC filtering in supply voltage lines on each board.

F.7 RF Combiner Motherboard Removal

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

All RF Combiner Motherboards are of similar construction and therefore will require the same basic procedure.

a. Remove all 16 RF Amplifier modules from the front.

b. Disconnect all wiring and cables from the motherboard that is being replaced.

c. Remove all screws on the Efficiency Coil supports.

d. Remove Efficiency Coil supports.

e. Remove Efficiency Coil support standoffs (1/4" hex).

f. Remove Efficiency Coil interconnect cables from J1 and J2.

g. Use Lifting Loops to pull Efficiency Coil boards from Motherboard. (NOTE: Try to progressively "walk" the board from the Mothterboard to prevent damage to banana connectors located along the board.)

h. Remove only as much of the combiner cover as necessary from the rear of the transmitter.

CAUTION

LOCATE AND REMOVE ANY HARDWARE THAT IS DROPPED. IF LOST HARDWARE IS REPLACED, MAKE SURE NONE OF IT HAS LODGED ON ANY RF AMPLIFIER MODULE.

i. Remove the 2 end screws from the combiner secondary rod.

j. Remove the motherboard fastening hardware beginning with the two 4-40 screws in the front center card guide support. The 4-40 screws to be removed can be identified by the 6 inch (15cm) aluminum rods attached to the card guide support bar.

1. Six screws on the outside right and left sides of the motherboard.
2. Four screws on the inside top and bottom of the motherboard.

k. Carefully remove the motherboard out the rear of the transmitter.

F.8 RF Combiner Motherboard Replacement

Replacement of the Main Combiner/Motherboards is essentially the reverse of the removal procedure.

a. During installation of a motherboard, it may not appear to fit in as easily as it came out. This is due to the blue card guides not fitting back in their slots at the same time. It is recommended that the board be installed and just a few of the screws be installed that mount the board to the supports. Then from the front of the compartment, place the card guides into their respective slots.

b. Once the motherboard has been fully mounted insert the Allen screws that bolt the Combiner rods together in place but do not fully tighten.

c. Loosen the two set screws that are on the fiberglass supports on the motherboard that hold the rod in place. Now tighten the Allen screws on the copper rod to 150 inch/lbs.

d. Retighten the set screws on the motherboard. Replace the Combiner cover, RF Amplifier modules, and the interconnection plugs.

e. Reverse of Removal Procedure.

CAUTION

REPLACE ALL COMBINER COVER SCREWS. THE MAJORITY OF COMBINER RF GROUND CURRENT FLOWS THROUGH THE COMBINER COVERS.

F.8.1 Adjustments

The only adjustments available are efficiency coil tap positions and the four Binary transformer tap settings, refer to the Frequency Change Procedure in Section V.

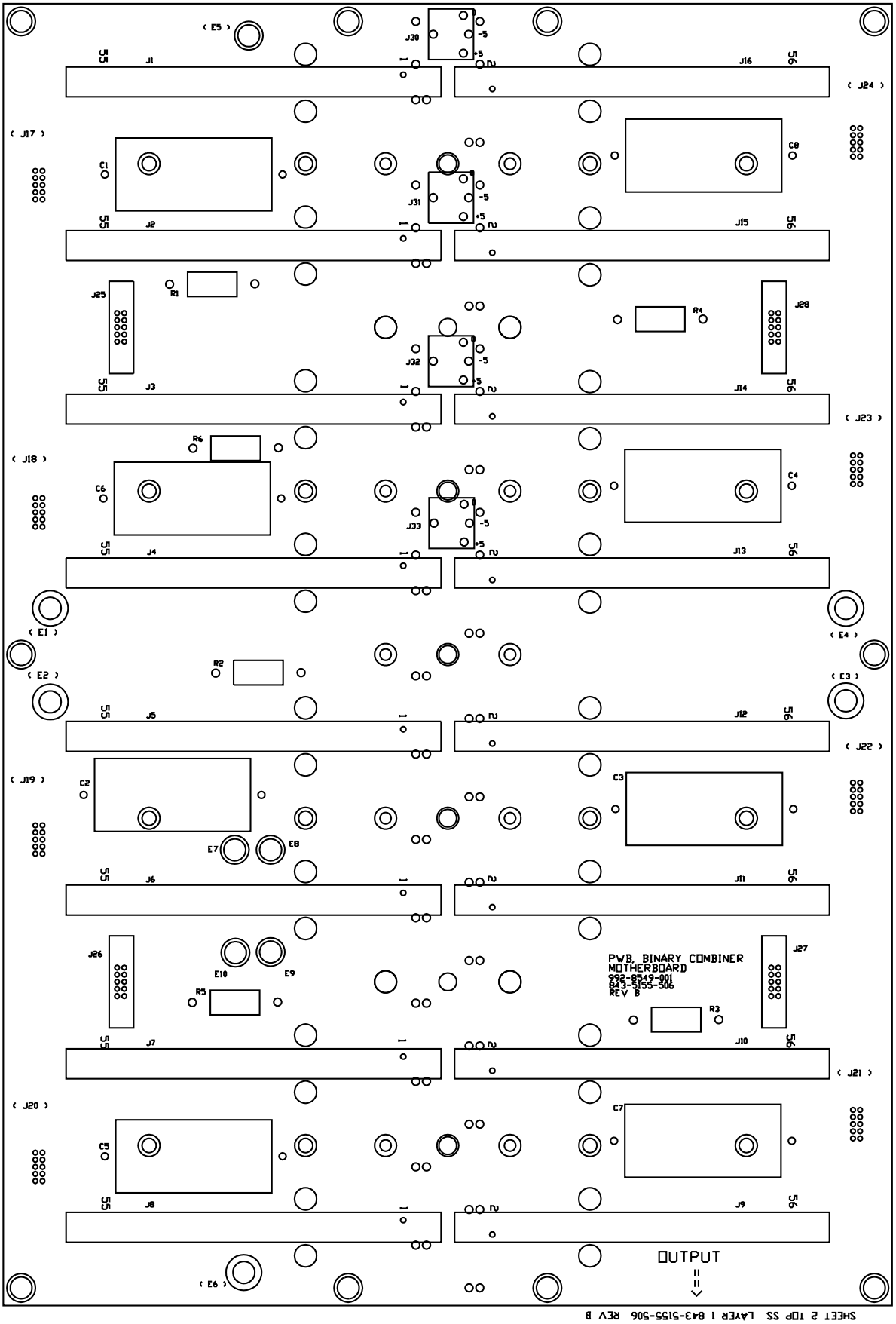


Figure F-1. Binary Combiner Motherboard (Front)
Component Locator

WARNING: Disconnect primary power prior to servicing.

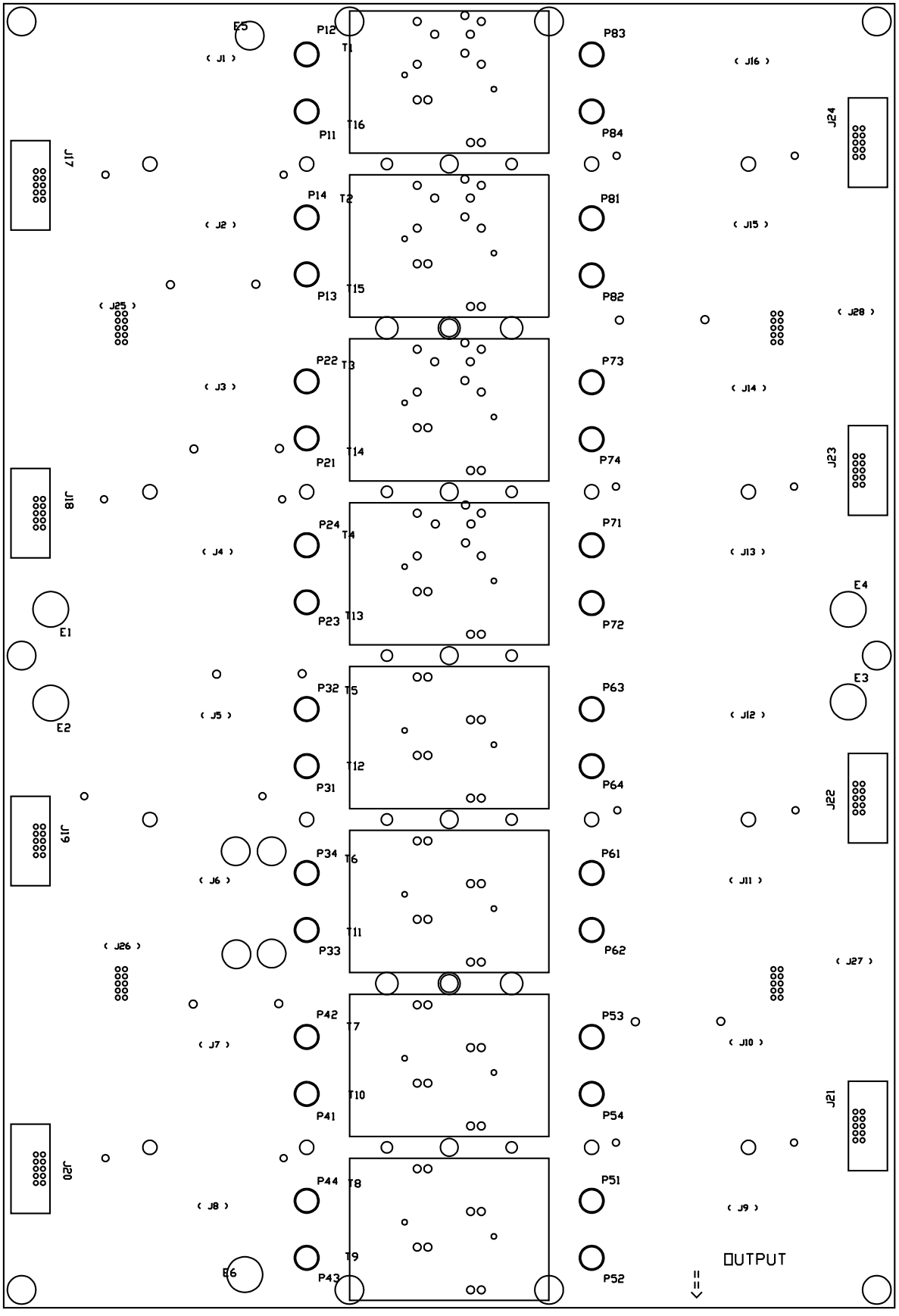


Figure F-2. Binary Combiner Motherboard (Rear) Component Locator

WARNING: Disconnect primary power prior to servicing.

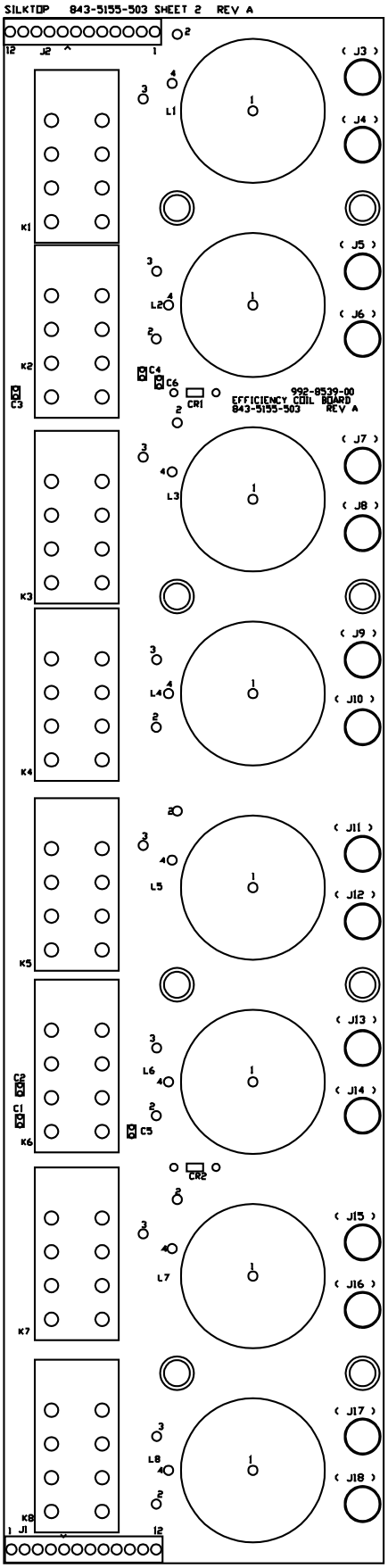


Figure F-3. Efficiency Coil Board Component Locator
Component Locator

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

G.1 Introduction

This section covers the RF Amplifier module. Topics include function, location, block diagram description, detailed circuit description, and troubleshooting.

NOTE: Parts List for this board is covered in Section VII.

G.2 Function

The transmitter contains a total of 175 RF Amplifier modules. Each module is a plug-in RF power amplifier which includes Class D Switching MOSFETs, RF Drive Transformers, On/Off Control Switches, and Cable Interlock/Fuse Fault Detectors.

All 175 RF Amplifiers are identical, and can be used in any of the following locations:

a. One (1) RF Amplifier Module, is used to amplify the Buffer Amplifier output and provide RF drive to the Drivers, D1- D14. It is referred to as the Predriver, PD1.

b. Fourteen (14) RF Amplifier modules, D1-D14, are used to amplify the Predriver output and provide RF drive to the Big Step and Binary Steps. They are referred to as the Drivers.

c. Four (4) RF Amplifier modules, B9-B12, are used to generate part of the RF Output signal. They are referred to as the Binary Steps.

d. One hundred and fiftysix (156) RF Amplifier modules, RF1-RF156, are used to generate the RF output signal. They are referred to as the Big Step Amplifiers.

G.3 Location

All RF Amplifier modules plug into combiner/motherboards, and are accessible from the front of the transmitter behind interlocked doors.

The Predriver (PD1), Drivers (D1-D14), Binary Steps, (B9-B12), and Big Steps RF136 to RF150 and RF156 are located in the right compartment behind the inner door. (SEE VIEW 10)

Big Steps RF63 to RF124, RF154 and RF155 are located in the center compartment behind the inner door. (SEE VIEW 12)

Big Steps RF1 to RF62, RF152 and RF153 are located in the left compartment behind the inner door. (SEE VIEW 14)

NOTE

Each RF Amplifier module contains the same identical circuits. The only difference will be the inputs and outputs to the module

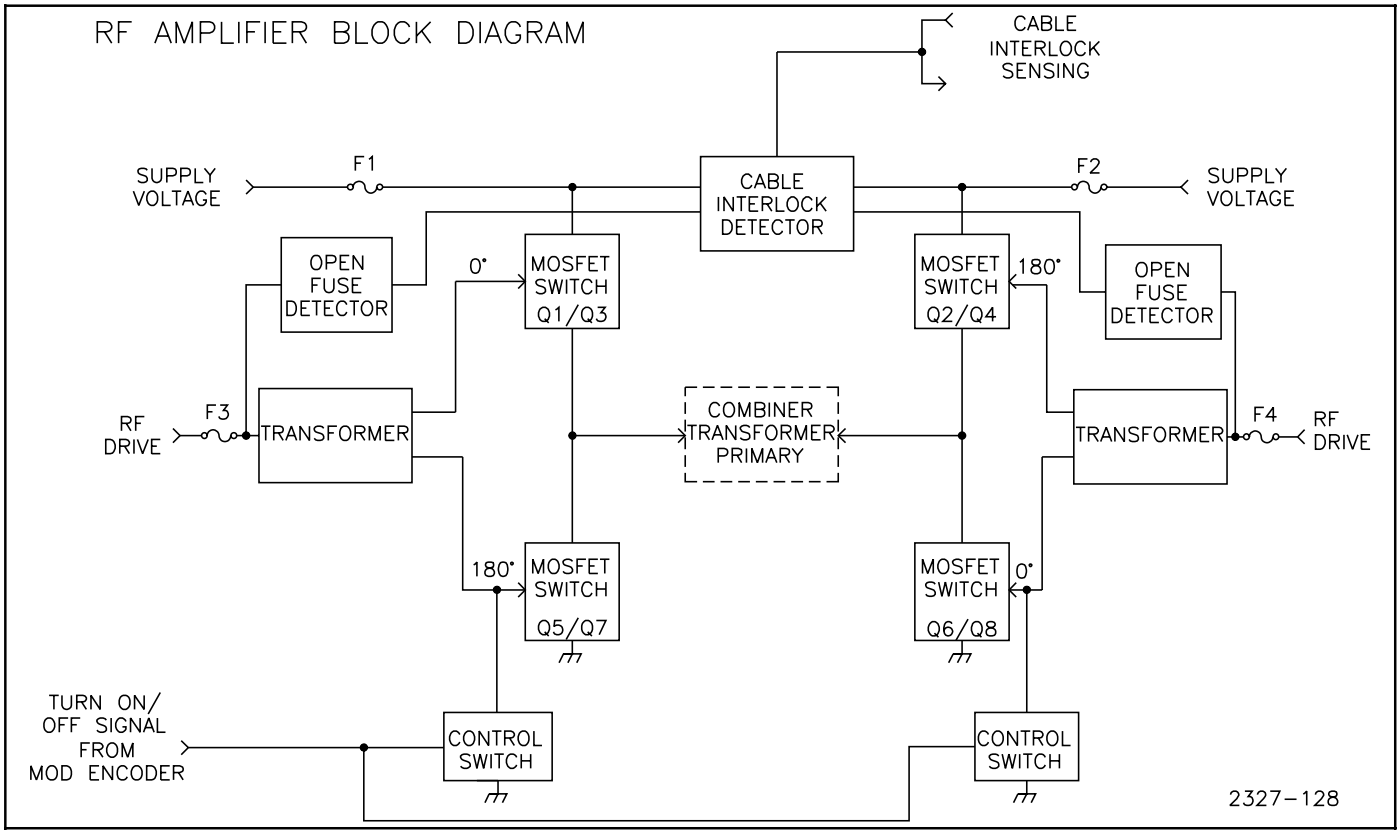


Figure G-1. RF Amplifier Block Diagram

WARNING: Disconnect primary power prior to servicing.

as determined by the function required. The following discussion applies to all RF Amplifiers, regardless of their location or use.

G.4 Block Diagram Description

The RF amplifier module is a Class D, Quad Bridged configuration.

Refer to Figure G-1 for the following discussion.

G.4.1 RF Flow

G.4.1.1 RF Drive

Two separate but identical RF drive sinewave signals (exactly equal in Phase and Amplitude), enter the module, and each is applied to an RF Transformer. Each RF Transformer, in turn, feeds pairs of MOSFET Switches with signals that are 0 and 180 degrees out of phase, referenced to the phase of the input RF drive signal.

G.4.1.2 MOSFET Switches

Refer to Fig. 1, RF Amplifier Block diagram for the following discussion. The module is divided into two halves, Section A and Section B. Section A consists of a pair of MOSFET switches (with each switch consisting of two paralleled MOSFETs) which are in series from the Supply Voltage to ground. Section B is identical, but is driven 180 degrees out of phase with Section A. A Combiner Transformer Primary is connected across the two pairs, in between the MOSFET switches. This is referred to as a Quad Bridged Configuration. Each MOSFET Switch is alternately driven into cutoff or saturation depending on the phase of the signal from the RF Transformer, thereby acting like a switch. The MOSFETs require a positive voltage on the Gate with respect to Source to turn ON. Therefore the MOSFETs Turn ON for one half of the RF input cycle, and turn OFF for the other half. For example, (See Figure G-2) for the first half cycle of the RF Drive input, if the upper switch in Section A is ON then the lower switch is OFF. Section B would be exactly opposite, in that the lower switch would be ON and the upper switch would be OFF. For the next half cycle of the RF Drive input, the lower switch in Section A would be ON and the upper switch would be OFF. Section B again would be the opposite and the upper switch would be ON and the lower switch would be OFF. The output signal across the Combiner Transformer Primary, for either half cycle is then switched between ground, (about zero Volts) and the positive supply voltage at an RF rate. Since the amplifier is a bridged configuration, the effective voltage across the Combiner Transformer Primary will be approximately twice the supply voltage.

G.4.1.3 On/Off Control Switches

The Turn ON/OFF Signal is applied to Control Switches that are connected to the drive signal on the lower pair of MOSFET Switches and ground. When the Turn ON/OFF Signal is high (positive), the module is turned "OFF" and the Control Switches are closed. Drive to the lower pair of MOSFET Switches is removed and therefore they remain in an open condition. When the Turn ON/OFF Signal is low (negative), the module is turned "ON" and the Control Switches are open. This allows drive on the lower pair of MOSFET Switches.

G.4.2 Cable Interlock

A single trace on the printed circuit board connects two pins of the corresponding edge connector together. If the module is missing or not properly connected to the edge connector, the Cable Interlock string will be broken and the transmitter cannot be turned on. Front Panel Module/Cable Interlock LED will be lit.

G.4.3 Fuse Open Detector

RF Drive and Supply Voltage Fuses are located on the module for protection of other circuits in the transmitter. Should any one of the fuses open, a lower than normal voltage is present on the Cable Interlock line that will activate Fuse Fault detection circuits.

G.5 Detailed Circuit Description

Refer to the RF Amplifier Schematic Diagram (839-7930-001), for the following discussion.

Refer to other Simplified Diagrams as requested.

G.5.1 RF Drive

G.5.1.1 Primary

RF drive for section A enters the module at P1-49 and RF drive for section B enters at P1-53. There is a separate RF fuse (F3 and F4) for each section, so that if a section should fail, the fuse opens and the failed section is disconnected from the driving source.

A network in parallel with each RF drive transformer primary broadbands the input circuit, so that no component changes are required for operation at any frequency in the AM broadcast band. For T1, this network consists of all the inductors, capacitors, and resistors drawn to the left of T1. The same is true for the components drawn to the right of T2.

When the module is turned "OFF", the voltage at the base of Q15 and Q17 is positive. Q15 is saturated and connects R7 and C5 to ground, meanwhile Q17 is turned off.

When the module is turned "ON", the voltage at the base of Q15 and Q17 is negative. Q15 is turned off and opens the ground for R7 and C5, while Q17 is saturated and grounds the base of Q15.

This action presents the same RF impedance to the driving source when the module is "OFF" that it has when the module is "ON". The same is true of Q16, Q18, R8, and C6 for section B.

G.5.1.2 Secondary

Each RF drive transformer has two pairs of secondary windings, which provide two pairs of drive signals, 180° out of phase, for the upper and lower MOSFET pairs in each section. On the schematic diagram, small circles at one end of each transformer winding indicate RF phasing.

Tranzorbs (Back-to-back zener diodes) CR1, CR2, CR3, and CR4 protect the MOSFET gates against overvoltages, including possible

WARNING: Disconnect primary power prior to servicing.

transient voltages. Each of these diodes conducts if the voltage across them exceeds 20 Volts, either positive or negative.

G.5.2 MOSFET Switches - Full Quad, Bridged Configuration

Figure G-2 shows the four pairs of MOSFETs as switches. The phase of the RF drive signals is such that only two combinations are possible for the switches when the module is "ON". During one half of the RF cycle (Figure G-2A), Q1/Q3 and Q6/Q8 are both driven to cutoff (open), while Q2/Q4 and Q5/Q7 are saturated (closed). During the other half of the cycle (Figure G-2B), Q1/Q3 and Q6/Q8 are saturated, and Q2/Q4 and Q5/Q7 are cut off.

Each section produces a square wave output, but the two square waves are 180 degrees out of phase. This switching action effectively applies the full supply voltage across the combiner transformer primary winding with opposite polarities on each half cycle of the RF Drive signal. Being a Bridged amplifier, this gives an effective RF output of twice the power supply voltage. Section A output at TP1 leaves the module through P1-1, and section B output at TP2 leaves the module through P1-7. The combiner motherboard connects the transformer to these two points. To prevent a direct dc current path through the combiner transformer winding to ground (for example if MOSFET's should fail), a capacitor C8 is placed in series with one section's RF output.

Small ferrite beads have been placed on the drain leads of MOSFETs Q5, Q6, Q7 and Q8, to prevent high frequency currents or oscillations.

G.5.3 MOSFET Switches - Half Quad, Single Ended

The RF Amplifier was designed to have a separate supply voltage and RF drive inputs to allow the "A" half to operate independently of the "B" half. This feature of the RF module is utilized in the Regulated Driver Module D14A and D14B, and in the Predriver module PD1. Figure G-3 shows the MOSFETs as switches for Section "A." Section "B" is identical in operation except, Q2,Q4 and Q6,Q8 are used. The squarewave RF output Waveform, at the junction of Q1,Q3 source and Q5,Q7 drain, will be approximately from 0 Volts to the supply voltage, at the transmitter's RF operating frequency. In this mode the RF output voltage is about half of the Bridged mode of operation. This provides some degree of redundancy because it is possible that one of the Full Quad, Bridged RF amplifiers could have a failure of only section "A," or only Section "B." Since a failure of either section would most likely be either a shorted MOSFET or an open fuse, the other half of the module would continue to operate normally. In this case it becomes a Half Quad module and would operate at reduced RF output voltage.

G.5.4 Control Switches

Figure G-4 shows the control switches for section A in the "ON" and "OFF" conditions. The same principals apply to section B

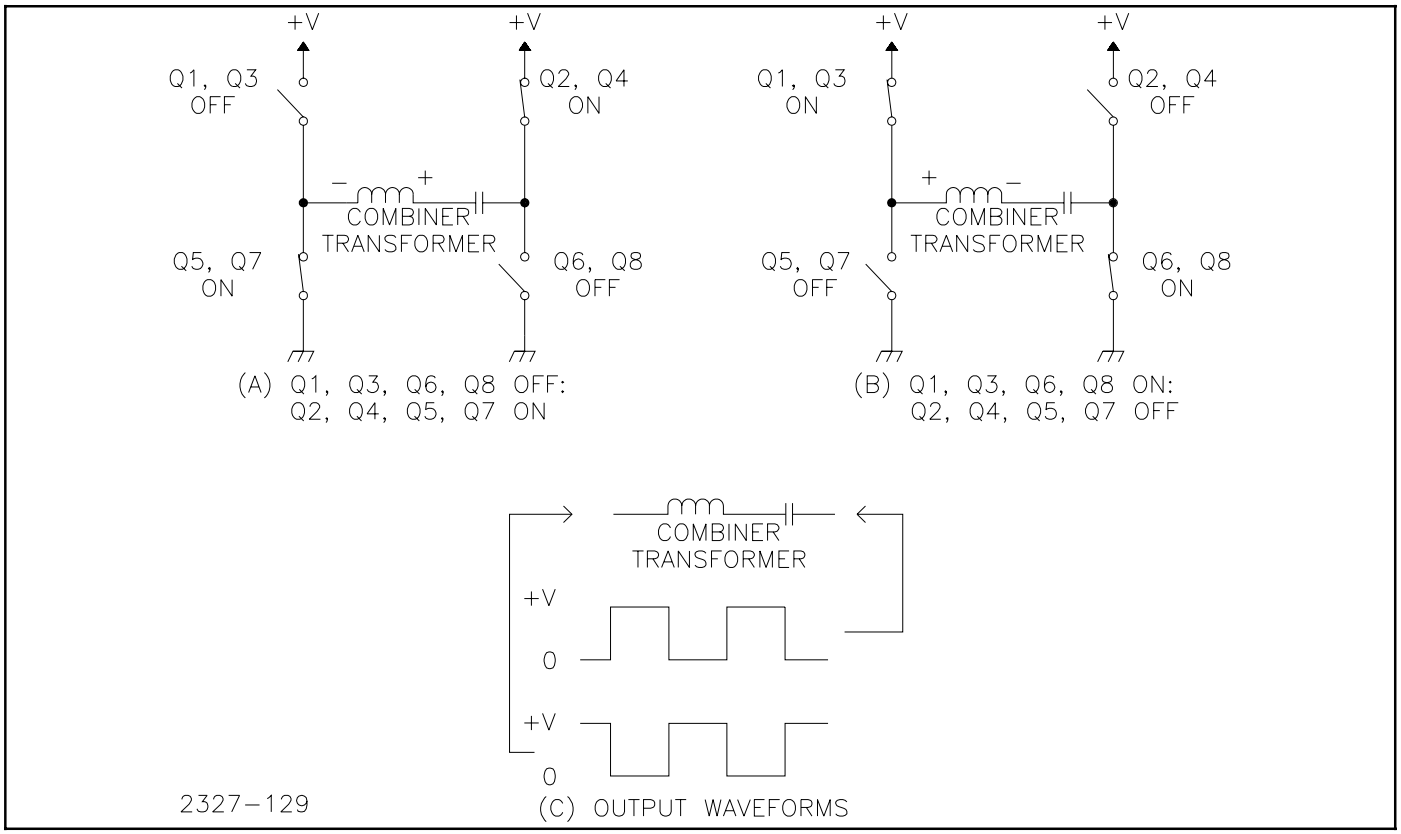


Figure G-2. RF Amplifier Full Quad Bridged Operation

WARNING: Disconnect primary power prior to servicing.

circuitry. ON/OFF control signals (from the appropriate Mod Encoder) enter at P1-45 and P1-46.

G.5.4.1 Module Turned "ON"

A negative control signal input (about -2 to -5 Volts) will saturate PNP transistors Q11 and Q13, so they act essentially as a short circuit. NPN transistor Q9 will be cut-off and effectively an open circuit.

A ground is therefore applied to the lower part of the two secondary windings of T1 and RF drive is then provided to Q5 and Q7 so they switch on when gate drive is positive. Diodes CR7 and CR9 rectify the positive RF gate drive and illuminate DS3 "RF AMPLIFIER ON" GREEN.

G.5.4.2 Module Turned "OFF"

A positive control signal of about +4.5V will cut-off Q11 and Q13, so they act as an open circuit, and will saturate Q9 essentially making it a short circuit. By shutting off Q11 and Q13, the ground for T1 is removed, and the RF drive to the gates of MOSFET's Q5 and Q7 are clamped to a diodes drop above ground by Q9 through CR7 and CR9. The positive voltage required to turn ON the MOSFET's (approximately +2 to +4 Volts gate relative to source) is taken away, therefore they remain open switches.

Schottky diode CR5 connected to Q11/Q13 and diode CR15 connected to Q9, protect the transistors from transient voltages.

Capacitor C16, connected between Q11/Q13 collector and Q12/Q14 collector on section B, improves the turn-on/turn-off characteristics of the amplifier.

Refer to Figure G-5.

When an RF Amplifier module is "OFF," there is no current flow from the supply through the combiner transformer primary, therefore the module does not supply any power to the combiner. Current will still flow through the combiner secondary, and will induce RF voltages in the toroidal transformer primary windings for all inactive modules.

When the polarity of the induced voltage in the combiner transformer is as shown in the diagram, a low-impedance RF current path is available through the reverse diodes inside Q1/Q3, bypass capacitors C1, C3, C4, and C2, through MOSFETs Q2/Q4, which are "ON," and through C8.

When the polarity of the voltage induced in the transformer winding reverses, Q1/Q3 must turn ON, and the current flow will now be through the reverse diodes in Q2/Q4.

G.5.5 Cable Interlock

The cable interlock control signal loops through the RF Amplifier on pins P1-35/36 and P1-37/38. The interlock signal originates and is processed on the Mod Encoder controlling the RF Amplifier.

G.5.6 Supply Voltage

The supply voltage for Section A goes through P1-23, and through P1-29 for Section B. Resistors R27 and R28 are placed in the supply line for filtering, and the drains of Q1/Q3 and Q2/Q4 are bypassed to ground by C1 and C3, and C2 and C4.

A separate 6 Ampere fuse is used for each section, and a RED LED indicator is across each fuse. DS1-R1 are for F1 and DS2-R2 are for F2. R1 and R2 limit LED current based on 230 VDC. The LED will always illuminate when a fuse opens due to a short circuit (i.e. failed MOSFET's or bypass capacitors).

The LED will also illuminate when the circuit is okay with the fuse open and the amplifier switched "ON". This also means that the LED may not be illuminated when a fuse is open of an amplifier assigned near the peak of modulation which is seldom switched "ON".

G.5.7 Fuse Open Detector

The Fuse Open Detector circuit is formed by diodes CR11/CR12 for Supply voltage fuses and by CR17/CR18 for RF fuses. Normally P1- 35 is established at about +15VDC by circuitry on the encoder when all fuses are ok.

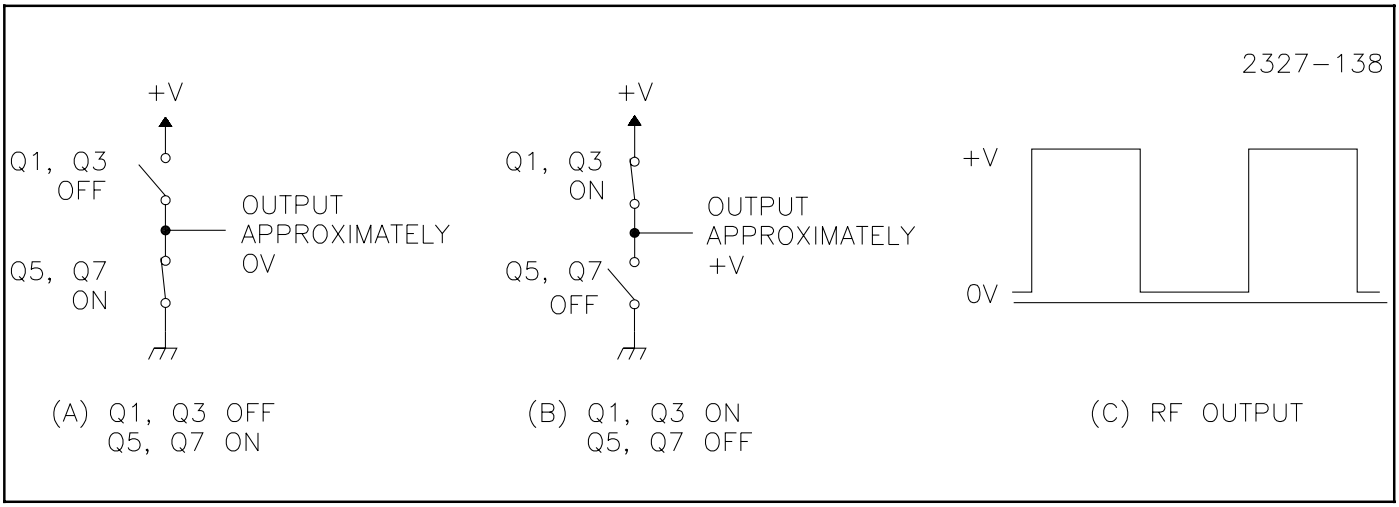


Figure G-3. RF Amplifier Half Quad Operation

WARNING: Disconnect primary power prior to servicing.

G.5.8 RF Drive Fuse Open Detector

RF Drive passed by F3 will conduct through CR19 and charge C11 to about 20VDC. CR17 is therefore reversed biased and P1-35 remains at +15VDC. If F3 opens, the charge on C11 will be removed and 20K ohms of resistance will effectively be placed to ground through CR17 and R19. This will lower the voltage going to the Mod Encoder and is used to trip a fault comparator which lights the RF Amp Fuse LED on the Front Panel. The same operation applies to circuitry connected to F4.

G.5.9 DC Supply Fuse Open Detector

If F1 opens due to shorted MOSFETs on section A, the voltage at P1-35 (normally +15VDC) will be shunted to ground through R31 and CR11. This will lower the voltage going to the Mod Encoder and is used to trip a fault comparator which lights the RF Amp Fuse LED on the Front Panel. The same operation applies to circuitry connected to F2. If CR11 or CR12 short, R31 and CR25 will clamp the 230 VDC present at F1 or F2 down to 20 Volts on the fuse open detector line (P1-35), thereby protecting the Mod Encoder.

NOTE: For more information on the Fuse Fault circuitry refer to Section L, Modulation Encoders.

G.6 Maintenance

G.6.1 Handling MOSFETs

Due to the fragile nature of the gate of a MOSFET, special care in their handling is required. The gate junction may be destroyed by static electricity if the static electricity is allowed to discharge through the MOSFET. For example, walking across a carpet to pick up a MOSFET that is not protected by antistatic packaging could result in the destruction of the MOSFET. A static charge could build up on a person as they walk across the carpet. This

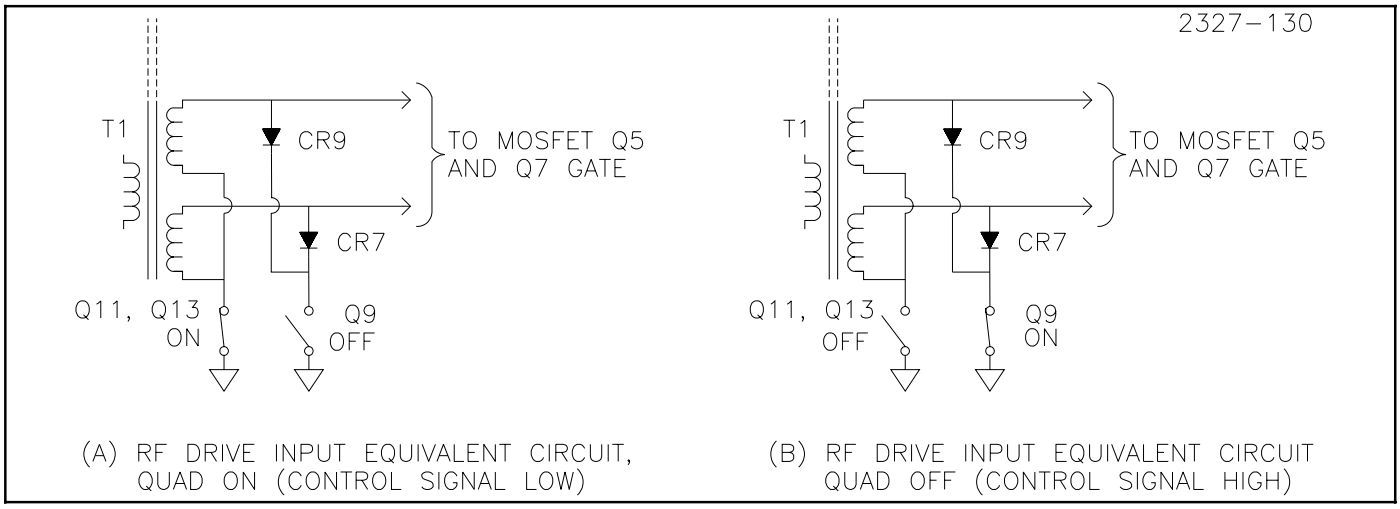


Figure G-4. RF Amplifier Simplified Control Circuit

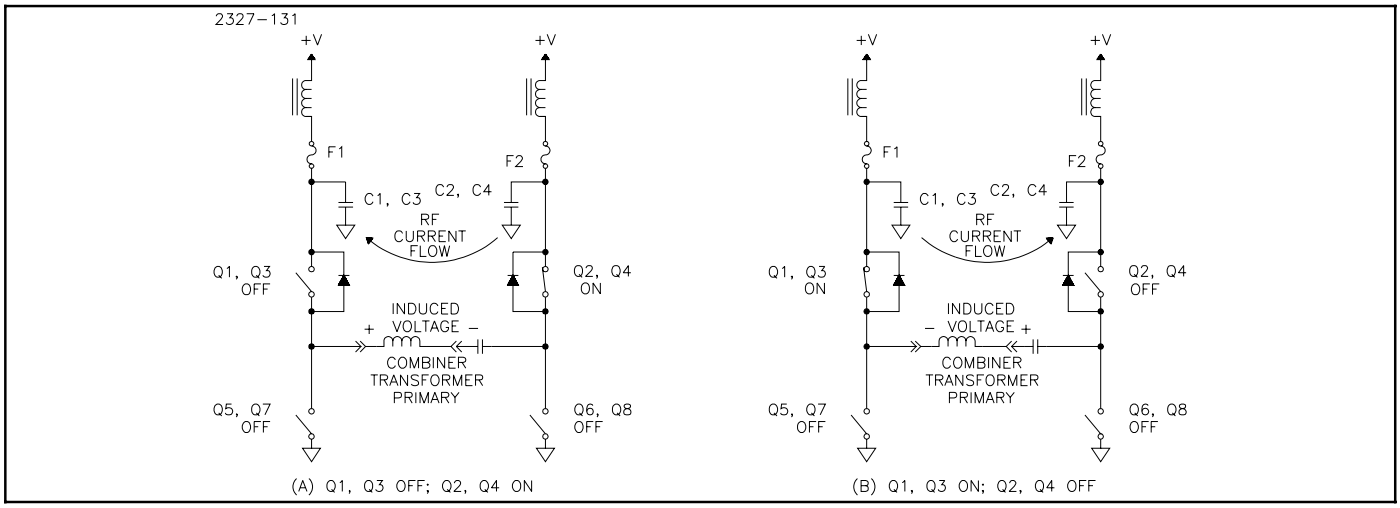


Figure G-5. Induced RF Current Path for Module OFF Condition

WARNING: Disconnect primary power prior to servicing.

static charge will eventually have to be discharged. Discharging to the MOSFET could damage the MOSFET.

NOTE

MOSFET transistors which are in circuit are immune to this damage.

The MOSFET transistors are shipped in antistatic packaging. The transistors should remain in this packaging until they are to be used or tested.

G.6.2 Testing MOSFETs

The MOSFETs will have to be removed from the circuit in order to perform the following test.

Observe the precautions in the paragraph entitled "Handling MOSFET'S" in this section.

The following test applies to all MOSFET's used in the transmitter, but is not necessarily applicable to MOSFET's used in other equipment.

The MOSFET's used in the transmitter may be checked with an ohmmeter. However there is a requirement which restricts the use of some ohmmeters. If the battery voltage is too low (under 3V) or too high (over 20V) the ohmmeter cannot be used. A battery voltage less than 3V will not give an operational check of the transistor and a battery voltage greater than 20V may result in damage to the transistor under test. A Simpson 260, which uses a 9V battery on the Rx10k scale works quite well.

This test will show how a MOSFET can be switched "on" and "off" by charging and discharging the gate of the MOSFET.

Refer to Figure G-6 for the following test. Connect the positive lead of the ohmmeter to the drain or case of the transistor. Connect the negative lead to source. Alternately touch a jumper from gate to source and then from gate to drain. The ohmmeter should read towards infinity or at least 2 megohms when the MOSFET is switched off and less than 90k ohms when the MOSFET is switched on. (To switch the MOSFET on hard, near zero ohms, use +5 VDC gate to source signal.) When doing this test, lay the MOSFET on a flat surface or hold sides of the case. The resistance of your finger tips and skin will effect the readings when you touch the leads.

G.6.3 Replacing MOSFETs

When repairing an RF Amplifier, it is recommended that all four MOSFET's of the failed half of a module be replaced. Even though only one or two of the four MOSFETs are found to be shorted, the remaining MOSFETs may have been stressed internally and may fail when supply voltage is reapplied. The repair process would then have to be repeated which can be very frustrating.

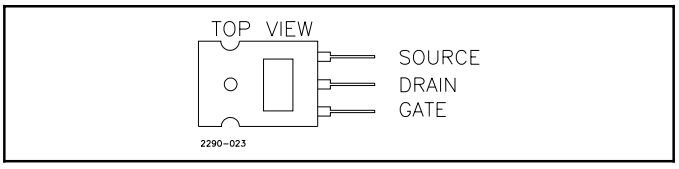


Figure G-6. Pin Identification of MOSFET

Blowing a fuse on one half of the amplifier does not effect the other half of the amplifier.

MOSFETs that appear to be undamaged after testing should be kept as spares for use if new replacements are not available. Also keep in mind that the amplifiers used in the Driver and PA are identical except that the Driver amplifiers operate at half voltage. This allows you to rotate a repaired module into the Driver position if so desired.

NOTE

In most cases, the transistor will stick to the heatsink because of seal created by the transistor pad. This seal will have to be broken before a heatsink can be removed. Pry the transistor out, away from its heatsink. DO NOT TRY TO PRY THE HEATSINK AWAY FROM THE PC BOARD WITH TRANSISTORS STUCK TO THE HEATSINK OR THE PC BOARD MAY BE DAMAGED AND THE HEATSINK MAY DISTORT. Sometimes the transistor pad will tear when the seal is broken, Remove stuck pieces and replace pad.

a. Remove all the screws from heatsinks and transistors.
b. Remove the heatsinks one at a time starting with the outer most sink. Break seals on transistor pads as each pair is exposed.
c. Replace failed transistors. Save and reuse the ferrite bead on the center leads of Q5/Q7 and Q6/Q8. Do not solder leads until heatsinks are in place.
d. Reattach the heatsinks in the reverse order in which they were removed in step b. Tighten heatsink and pc board screws first and then tighten transistor screws (torque to 3 inch-lbs).
e. Make sure the ferrite beads are on the center leads of Q5/Q7 and Q6/Q8.
f. Solder transistor leads and trim.
g. Replace blown fuse(s).

G.7 Troubleshooting RF Amp Modules

This section deals with faults on a single module. For problems involving multiple modules refer to the Transmitter Troubleshooting Section first.

Before troubleshooting the module, verify that the problem exists on the module by swapping the suspected bad module with another working module in the transmitter. If the problem does not follow the module refer to the Combiner Section to continue.

After it has been verified that the problem is on the module, begin troubleshooting by observing the LEDs on the Module when the transmitter is running.

G.7.1 DS3 Not Illuminated

If this LED is not illuminated, the module is not being turned on or no RF drive is present.

a. Move the module to a position that has DS3 illuminated.

WARNING: Disconnect primary power prior to servicing.

1. If the LED still does not light, check F3 and F4.
2. If the fuse(s) are open, check for a shorted T1, T2, C11 or C12.

b. If the fuses are not open:

1. Verify the presence of RF drive on the RF Amplifier. Refer to Section VI, Troubleshooting paragraph title "Measuring RF Drive."
2. It should be 22 to 25 Volts p-p with a negative DC offset.
3. If the RF Drive waveform has no DC offset (is centered on the 0VDC axis) that side is on, check Q9 and Q10 and DS3 for a short.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

4. If the signal on CR3 and/or CR4 is negative, turn off the transmitter and remove the module.
5. Using an Ohmmeter check Q15, Q17, Q13, Q11, Q9 for side A and Q10, Q12, Q14, Q18, and Q16 for side B.

G.7.2 DS3 Illuminated

This is a normal condition when the step should be turned on.

a. If the LED will not extinguish when the module should be turned off:

1. Turn off the transmitter and remove the module.
2. Using an Ohmmeter check Q15, Q17, Q13, Q11, Q9 for side A and Q10, Q12, Q14, Q18,and Q16 for side B.

G.7.3 DS1 Illuminated RED

If DS1 is illuminated, this indicates that F1 is open and that the MOSFETs Q1, Q3, Q5, and/or Q7 may have failed.

a. Remove the module from the transmitter and ohmmeter check the transistors using the Testing MOSFETs steps in the Maintenance part of this section.
b. If a single MOSFET in a pair is found to have failed (Example Q3 shorted Q1 okay), the entire set of 4 MOSFETs should be replaced.

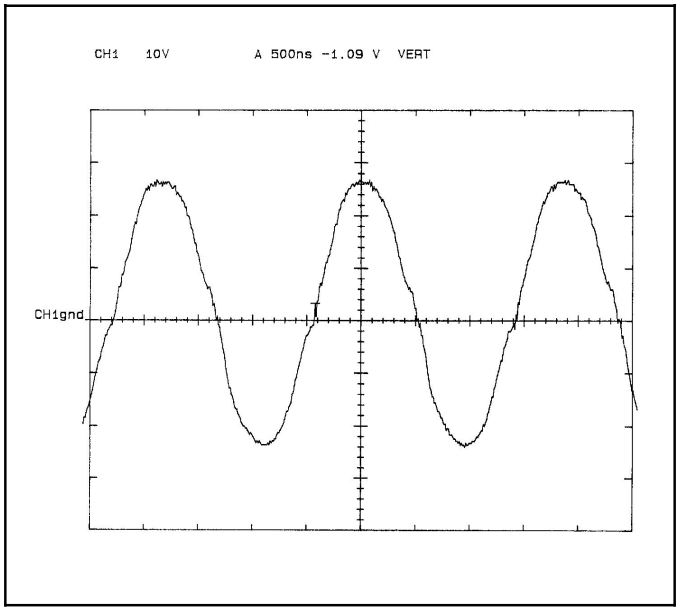
G.7.4 DS2 Illuminated RED

If DS2 is illuminated this indicates that F2 is open and that the MOSFET's Q2, Q4, Q6, and/or Q8 may have failed.

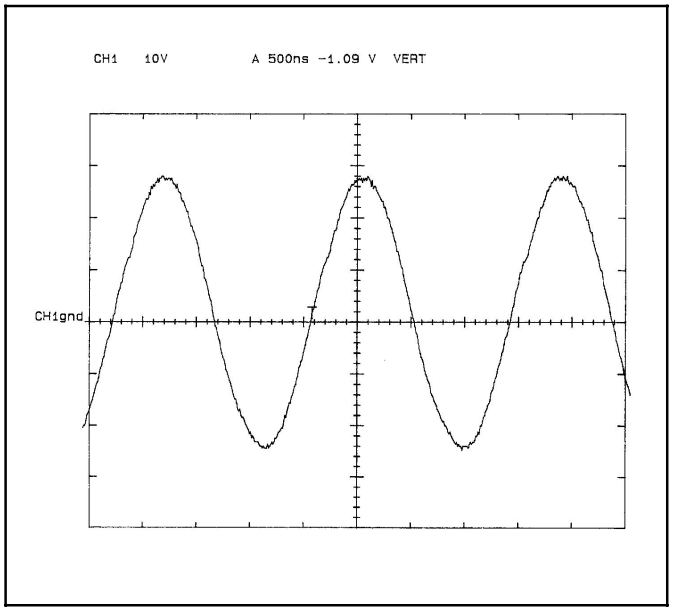
a. Remove the module from the transmitter and ohmmeter check the transistors using the Testing MOSFETs steps in the Maintenance part of this section.
b. If a single MOSFET in a pair is found to have failed (Example Q2 shorted Q4 okay), the entire set of 4 MOSFETs should be replaced.

G.7.5 Excessive Drive Phase Difference

a. Measure the drive phase on the RF Ampifier using the procedure provided in Section V.
b. If a module is out of specifications on drive phasing, first substitute a new module.
c. If the module is the problem it is most likely caused by:
   1. A defective drive transformer, T1 or T2 or
   2. A defective MOSFET, or associated circuitry.
d. If a module has just been repaired, check the ON/OFF components, such as transistors and diodes. A poor solder



P1-50



P1-50 (RFA OFF)

connection can cause a drive phase problem on an RF module. Substitution is the only way to troubleshoot this problem.

G.7.6 Excessive Drain Phase Difference

a. Measure the drain phase on the RF Ampifier using the procedure provided in Section V.

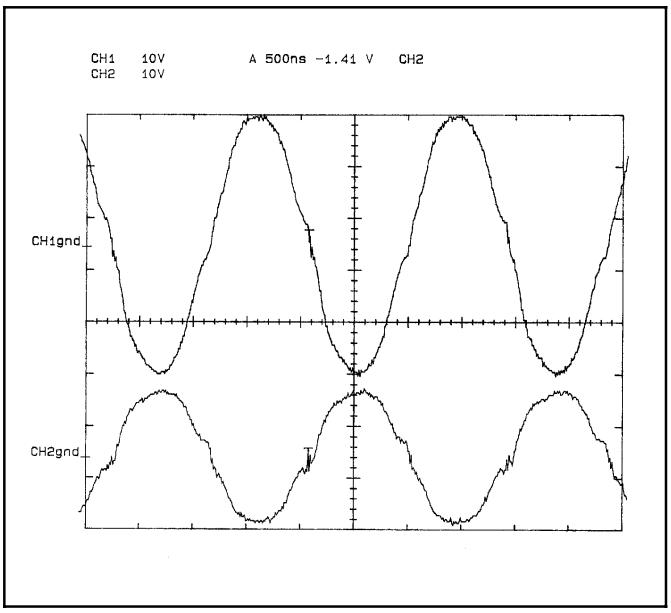
b. If a module is out of specifications on drain phasing, first substitute a new module.

c. If the module is not the problem the drive phasing should be checked.

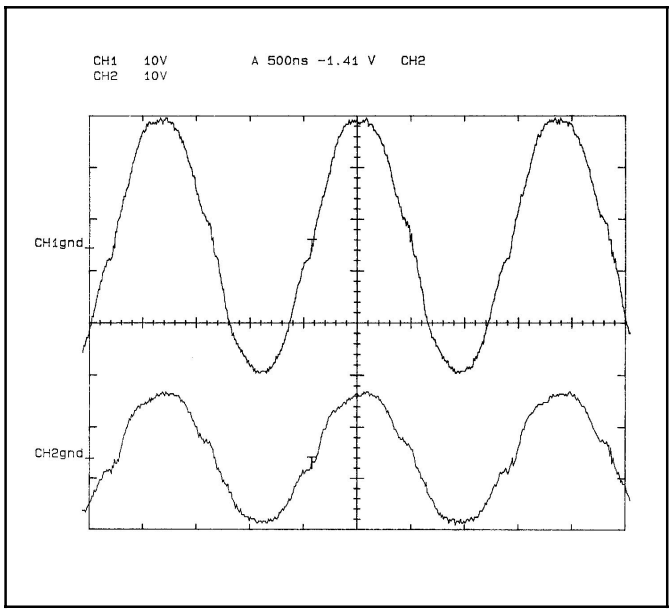
d. The only other cause of drain phasing problems on a module would be the MOSFETs themselves. Substitution is the only way to troubleshoot this problem.

G.7.7 Open Fuse Sensing Failure

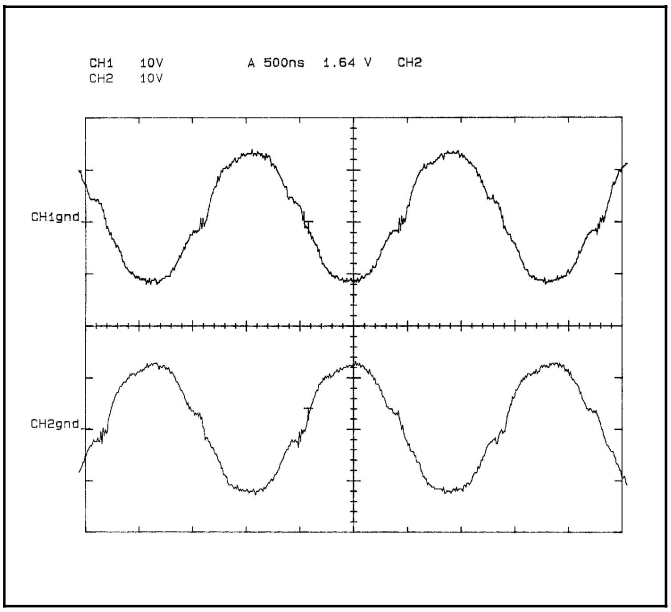
If the Control front panel displays an RF AMP fuse fault and it has been traced to a failure in the module sensing, use an ohmmeter and check diodes CR11, CR12, CR25, CR17, CR18, CR19, CR20. Check C11 and C12 for a short if the diodes test correctly.



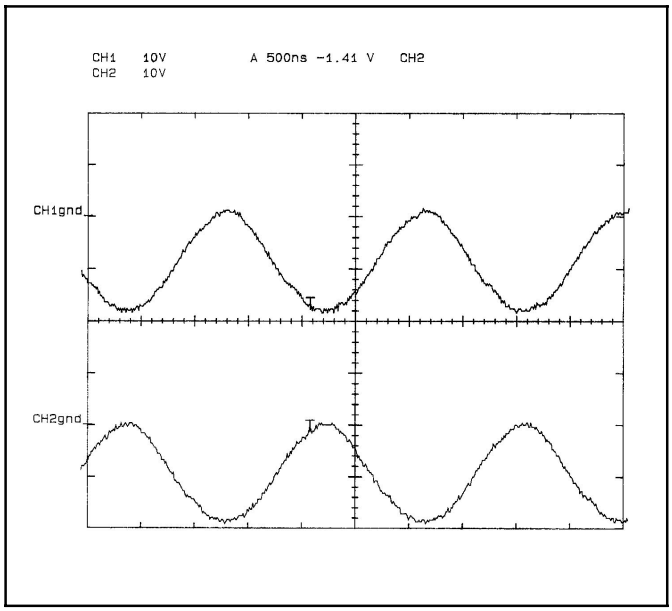
CH1 P1-50
CH2 Q7 Gate



CH1 P1-50
CH2 Q8 Gate

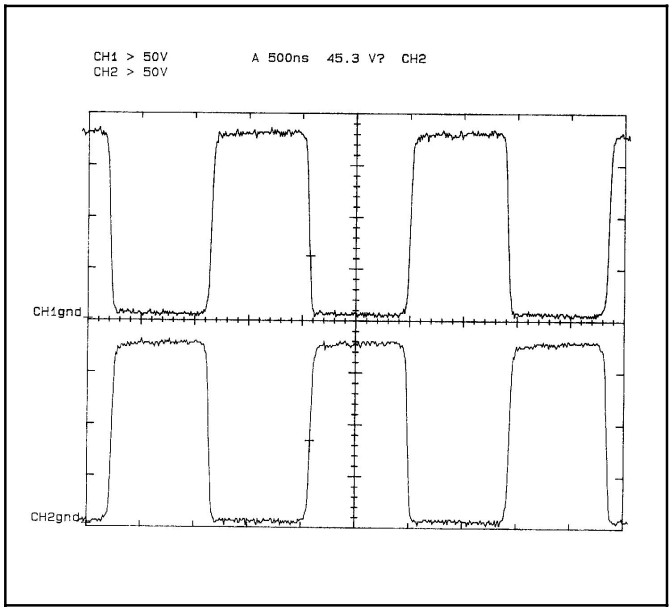


CH1 Q7 Gate
CH2 Q8 Gate

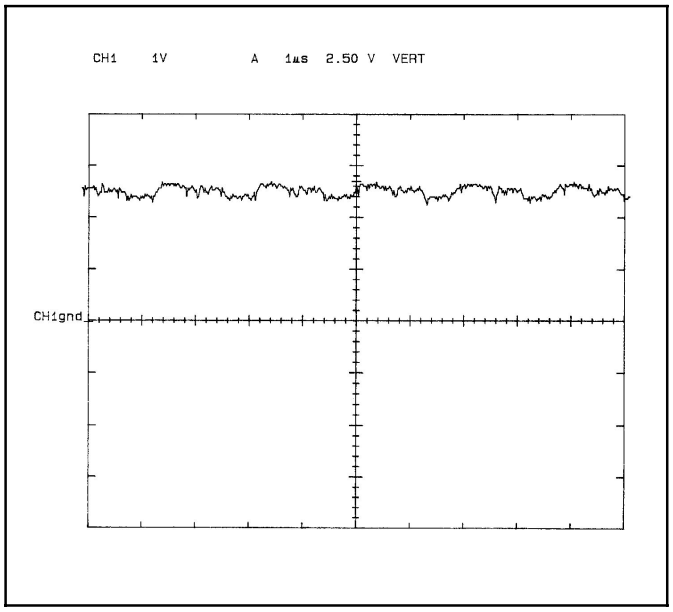


CH1 Q7 Gate
CH2 Q8 Gate
(RFA OFF)

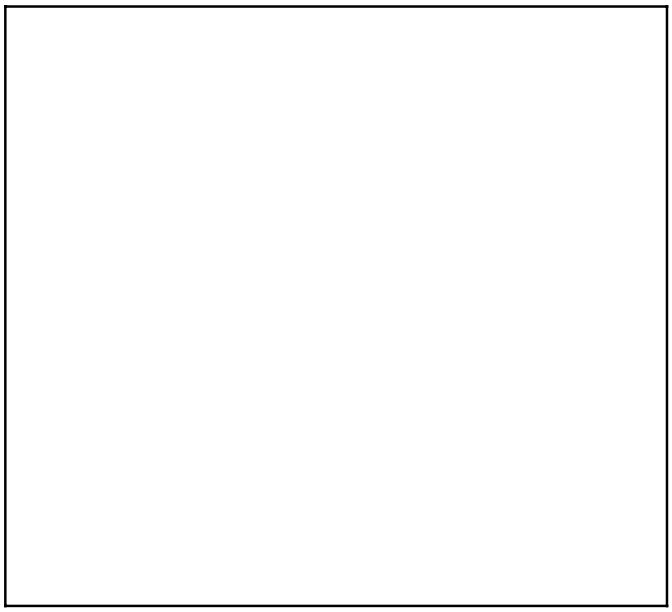
WARNING: Disconnect primary power prior to servicing.



CH1 TP1
CH2 TP2
(230V p-p)



P1-45 (RFA OFF)



Junction of L11 and C17 (RFA OFF)

WARNING: Disconnect primary power prior to servicing.

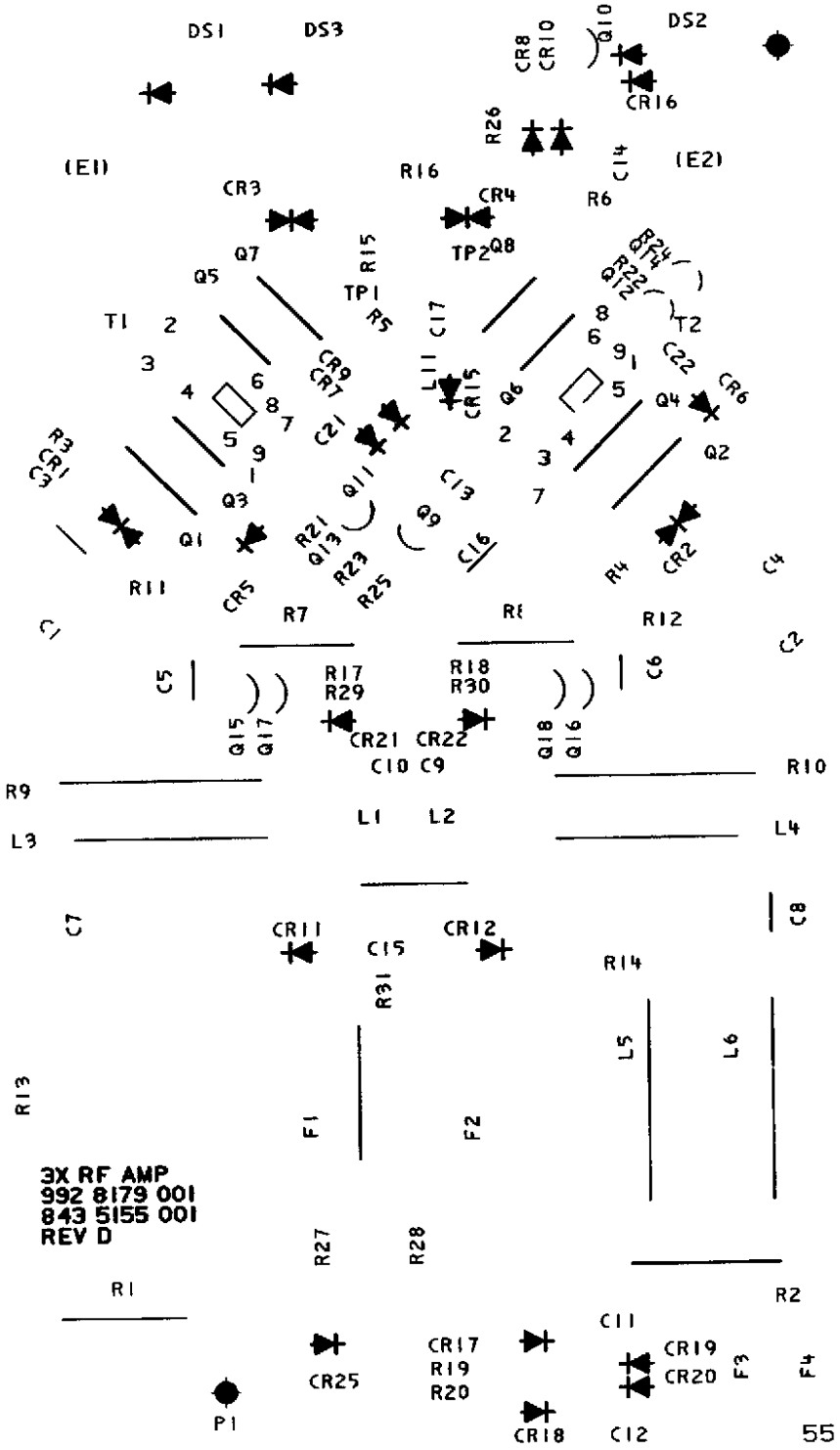


Figure G-7. RF Amp Component Locator

WARNING: Disconnect primary power prior to servicing.

Section H
Output Monitor/Output Sample

H.1 Introduction

This section covers the Output Monitor board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal/replacement.

Note: Parts List for this board is covered in Section VII.

H.2 Function

The Output Monitor board includes VSWR Detectors, VSWR Self Test, ARC Detectors, Directional Coupler, Modulation Monitor Sample Equalization circuits, Audio Detector, Airflow Monitoring, and Supply Fault circuits.

H.3 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100 kW with no modulation at 585 kHz carrier frequency.

H.4 Location

The Output Monitor board is located in the left side of the Left PA compartment. (SEE VIEW 14)

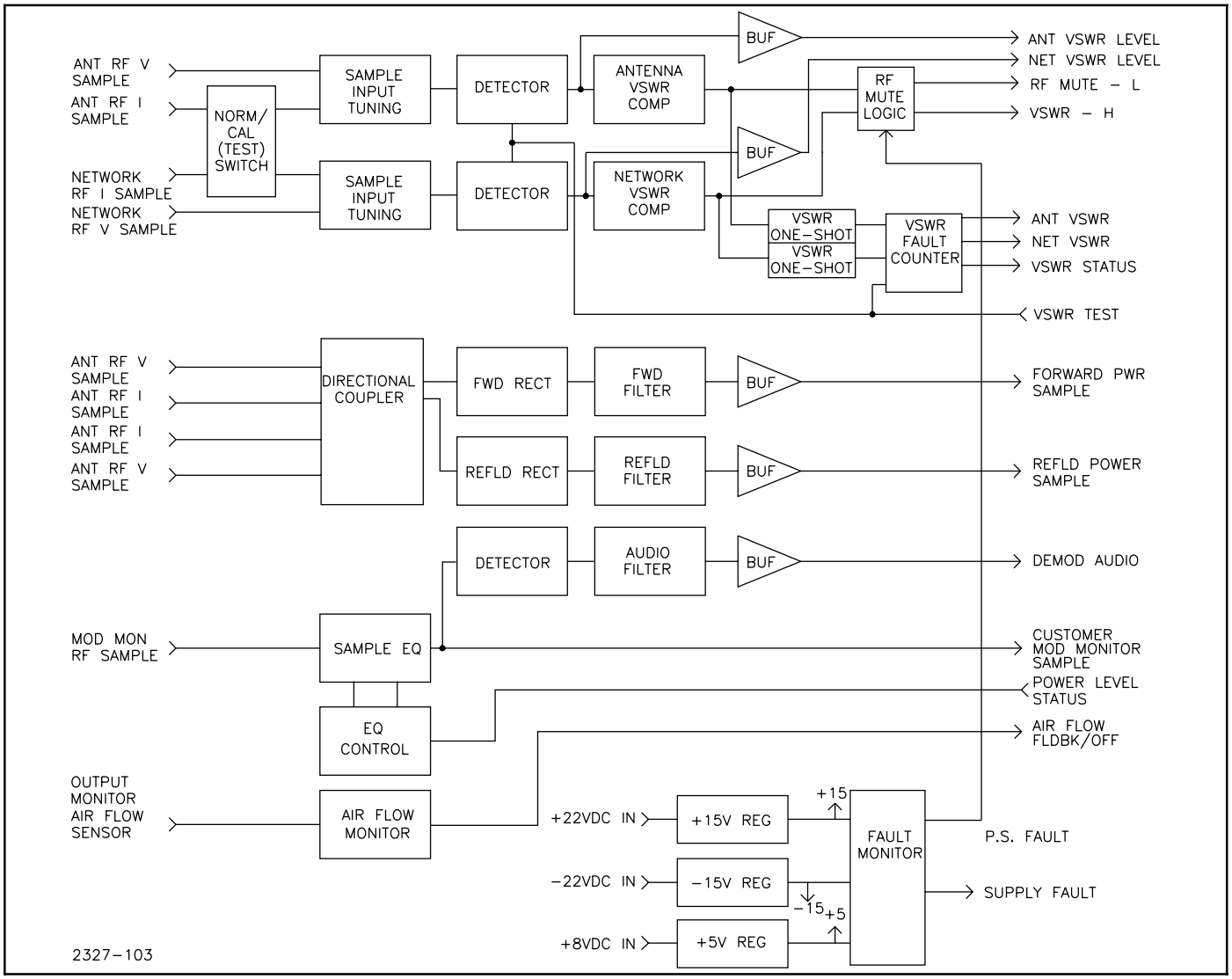


Figure H-1. Output Monitor Block Diagram

WARNING: Disconnect primary power prior to servicing.

H.5 Block Diagram Description

H.5.1 VSWR Detectors

Two types of VSWR detectors are provided: Antenna and Network VSWR. The purpose of the Antenna VSWR detector is to sense an impedance change external to the transmitter. The Network VSWR detector is for sensing a problem within the output network. Both detectors are metered on the front panel, plus initiate fault protection circuits in the event these values exceed safe limits.

H.5.2 ARC Detectors

Upper/Lower ARC Sensor Inputs are connected to their respective ARC Detectors and connected to the VSWR Test Logic circuits. Either type fault is treated as a Network VSWR Fault.

H.5.3 VSWR Logic

If either type VSWR is severe enough, VSWR Comparators will generate signals that are applied to the VSWR Logic. Either input will cause the VSWR Pulse Generator to produce an RF Mute and activate the VSWR Synthesizer Sync Switchover function. If VSWR is severe, the VSWR Foldback will produce Antenna/Network VSWR Faults that will cause power level Foldback, until a safe operating level is reached.

H.5.4 VSWR Self Test

When a VSWR Self Test Request is received, the VSWR Self Test and VSWR Test Logic will purposely create both types of Faults. The VSWR Test Status output is used to indicate the condition of the protection circuits.

H.5.5 Directional Coupler

Antenna RF Voltage and RF Current samples from the Output Sample board are applied to the Directional Coupler. These samples are then applied to a Rectifier, Filter, and a Buffer amplifier which provides Forward/Reflected Power DC Samples for front panel metering.

H.5.6 Modulation Monitor Sample

An RF Sample from the output is connected to Sample Equalization circuits. The AGC Control takes a sample of the Demodulated Audio to control the amount of Equalization so that the External Modulation Monitor Sample is the same over the three power levels.

H.5.7 Audio Detector

A Detector, Audio Filter, and Buffer amplifier are connected to the Sample Equalization circuit and provides a Demodulated Audio signal for testing purposes.

H.5.8 Air flow Monitor

An Air Flow Sensor in the Output Cabinet is connected to the Air Flow Monitor. The Monitor can generate an Air Flow Foldback Fault if the Sensor determines it is required.

H.5.9 Power Supplies

An unregulated +22VDC, -22VDC and +8VDC are regulated to +15VDC, - 15VDC and +5VDC respectively to power circuits on the board.

A Supply Fault Monitor monitors these supplies and can generate a Supply Fault to the Controller.

H.6 Detailed Circuit Description

Refer to the schematic diagram for the Output Monitor board (8435400851) for all descriptions in this section.

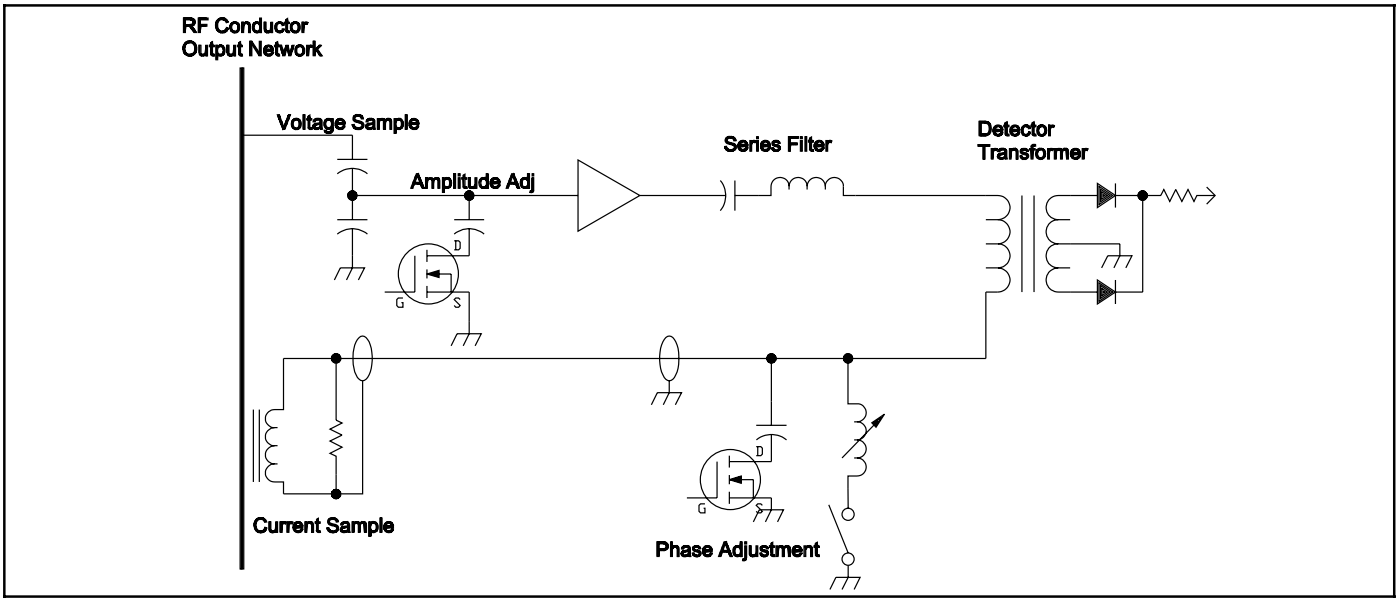


Figure H-2. VSWR Detector

WARNING: Disconnect primary power prior to servicing.

H.6.1 VSWR Detectors

The Antenna VSWR Detector and the Network VSWR Detector operate on the same general principle, with a detector transformer and rectifiers responding to changes between two RF samples.

Current and voltage samples are taken from the output network, and are matched in amplitude and phase, using various tuning and phase shift components. These two samples are then applied to the primary side of the detector transformer. When they are matched in amplitude and phase, there is no differential voltage across the transformer primary, and thus no output from the transformer. Any change in impedance then causes a change in the relationship between the current and voltage samples. This causes a voltage differential, and the VSWR reading will rise. If severe enough, a VSWR fault is initiated by the comparator circuitry that is fed by the detector rectifier circuit.

Refer to the functional diagram, Figure H2. In the case of the Network VSWR circuit, a current sample is taken by a toroid near the ground end of the combiner rod, and a voltage sample is taken from the combiner rod where it connects to the output network. A capacitive voltage divider is used to sample the voltage on the combiner rod.

Shunt tuning elements are provided on the Output Monitor board so that the phase of the current sample can be made to match that of the voltage sample. This is done by a selection of coils and capacitors. The coils are switched in by relays, and the capacitors are switched in by FETs.

The amplitude of the voltage sample is adjusted by varying the amount of capacitance in the voltage divider circuit. This allows the amplitude of the voltage sample to be adjusted to match that of the current sample. This is accomplished using a binary weighted selection of capacitors that are switched in by FETs. Adding more capacitance to the circuit by switching on more FETs reduces the voltage sample.

The voltage sample from the combiner rod is rich in harmonics, and so it is necessary to filter out the harmonic energy such that we have a clean signal. A series tuned filter on the output of buffer amplifier U1 provides this filtering. Relays control which capacitors and inductors are in circuit for a given frequency.

When properly adjusted, amplitude of the voltage sample is set to equal the amplitude of the current sample, and the phase of the current sample is adjusted to match the phase of the voltage sample. When this is accomplished the signals on the ends of the primary winding of the detector transformer are equal in amplitude and phase. Thus, with the circuit nulled (no voltage differential), there will be zero voltage on the secondary of the transformer, and thus a zero reading on the VSWR detector. Any subsequent change in impedance causes a change in the relation-

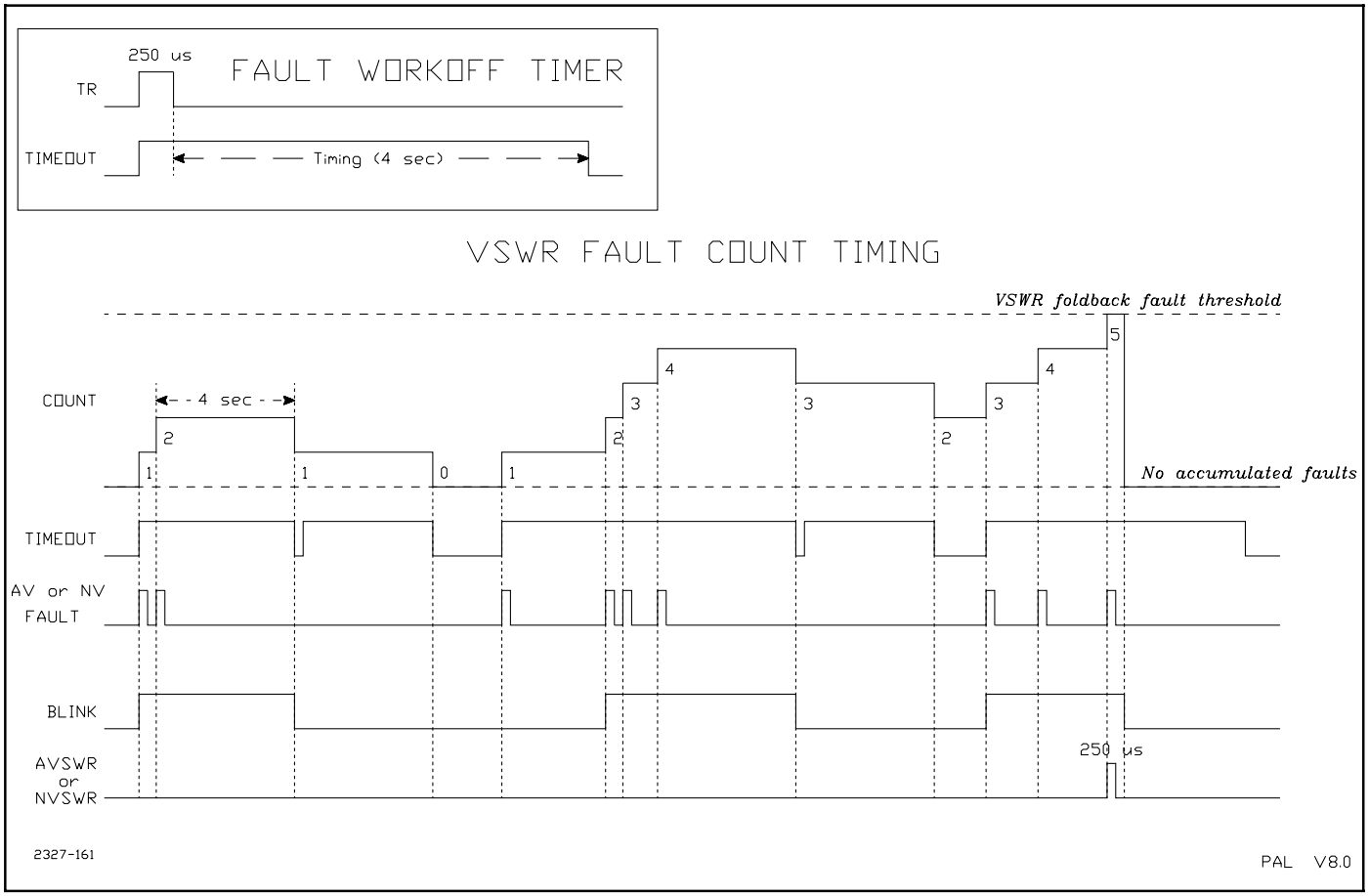


Figure H-3. VSWR Logic Timing Diagram

WARNING: Disconnect primary power prior to servicing.

ship between the voltage and current. This results in output from the detector circuit.

The Antenna VSWR detector circuit is very similar to the Network VSWR circuit. However, the RF samples are taken near the output terminal of the transmitter by the Output Sample board.

H.6.2 Frequency Selection

There are 3 independent setups for the Antenna VSWR, Network VSWR, Forward Power, and Reflected Power. These 3 setups are used to satisfy the alignment for each of the 3 frequencies of operation.

Refer to sheet 4 of schematic diagram 8435400851. Control signals at J8-5, J8-7, and J8-9 determine which of the 3 frequencies is selected. An active Low lights the corresponding led, and drives the corresponding Schmitt trigger output high. Only one input is driven Low at a time, as determined by the frequency select control circuit on another board.

The voltage on U5 outputs 2, 4, and 6 provide control voltages designated as “Control 1”, “Control 2”, and “Control 3”. These voltages drive the FETs that determine which RF components are in circuit. In the case of the Forward and Reflected metering circuits shown on sheet 4, U5 drives Q40, Q41, and Q42 to select the calibration components for each frequency. In the case of the VSWR detection circuits, the control voltages are applied to the array of switches that select which RF components are in effect. Diodes are used to OR the voltages to the appropriate FET so that one switch setting does not interfere with another.

H.6.2.1 Normal/Calibrate Test Switch

The Normal/Cal switch is used during factory testing to verify proper resonating of the transformer primary circuit. When the switch is in the Cal position, the current samples are connected to ground. The voltage samples will apply an RF voltage to one end of the transformer primary. With an oscilloscope connected to the other end of the winding, the circuit is tuned to resonance when the RF voltage indication on the oscilloscope is minimum.

H.6.3 Network VSWR Detector

The secondary winding of T1 is connected to a full wave rectifier and filter capacitor. The output DC voltage can be measured at TP19 Network VSWR and is connected to the Network VSWR Comparator and the Network VSWR Buffer.

H.6.4 Network Fault Comparator

This circuit uses a very high-speed differential comparator, U7. One input to the comparator is an adjustable positive reference voltage from the Output Network VSWR Threshold control, R139, and the other input is the dc signal from the detector. Diodes protect the comparator’s input from transient voltages. Normally, the detector output will be essentially zero volts, and the comparator’s output will be logic low. When the detector output exceeds the reference voltage during a VSWR fault condition, the comparator output will go logic high.

H.6.5 Network VSWR Buffer

The detector output is buffered and connected to the NET NULL position on the front panel multimeter. This is a relative reading only and when the detector is properly balanced the meter should read near zero.

H.6.6 Antenna VSWR Detector

The secondary winding of T3 is connected to a full wave rectifier and filter capacitor. The output DC voltage can be measured at TP7 Antenna VSWR and is connected to the Antenna VSWR Comparator and the Antenna VSWR Buffer.

H.6.7 Antenna Fault Comparator

This circuit uses a very high-speed differential comparator, U10. One input to the comparator is an adjustable positive reference voltage from the Antenna VSWR Threshold control, R130, and the other input is the dc signal from the detector. Diodes protect the comparator’s input from transient voltages. Normally, the detector output will be essentially zero volts, and the comparator’s output will be logic low. When the detector output exceeds the reference voltage during a VSWR fault condition, the comparator output will go logic high.

H.6.8 Antenna VSWR Buffer

The detector output is buffered and connected to the ANT NULL position on the front panel multimeter. This is a relative reading only and when the detector is properly balanced the meter should read near zero.

H.6.9 VSWR Pulse Generator

When either the Antenna or Network VSWR Comparator output goes active high, several events occur:

H.6.9.1 Local RF MUTE

The active high output turns on the transistor that generates an active high RF MUTE Local at TP30. This serves two functions:

a. First, another transistor turns on pulling the RF MUTE line J6-21 and TP28 low for 12mS. This action turns all the Big Step and Binary RF Amplifiers off for 12ms.

b. Second, a third transistor is turned on for 250nS and its output is inverted. The 250nS VSWR-H signal at TP29 and J6-19 is sent to the Synthesizer Interface board for activating the Synthesizer Sync circuit.

H.6.9.2 VSWR One-Shot

a. At the same time, the B input of one-shot also goes logic high, and this starts a timing cycle that lasts 0.5 seconds.

b. The Antenna VSWR or Output Network VSWR LED will be illuminated RED for this duration to give a visual indication of the fault.

1. The input to the VSWR PAL will also go logic high for this duration and be counted by the PAL as 1 VSWR trip.

NOTE

In the case of Antenna VSWR only, a inverter disables the Network VSWR input to the PAL.

H.6.9.3 Power-Up Reset

When low voltage is first applied to the board, the Power-Up Reset supplies a logic low that clears the one-shots.

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H.6.10 VSWR PAL

This PAL contains resettable VSWR trip counters.

H.6.10.1 Single VSWR Trip

When the VSWR PAL U11 receives a single active high VSWR trip signal from either one-shot, it executes the following functions:

a. The 4 Second Timer Request output will go logic high and start the 4 Second Timer. The 4 Second Timer output will go logic high, and is connected back into the PAL.

b. During the 4 Second long Timeout, the Blink output is logic high, and the VSWR Test Status and J6-9 is logic low. This low pulse holds the VSWR Test Status LED on the Control front panel RED for 4 seconds. This keeps the LED on long enough for the operator to see that a VSWR trip occurred.

c. The VSWR PAl will count to one internally.

d. After the Timeout pulse goes low, the LED will return to GREEN and the PAL counter will reset itself to zero.

H.6.10.2 Multiple VSWR Trips

If 5 VSWR trips occur within approximately 20 seconds, the transmitter will Foldback power by one step. One VSWR trip is uncounted or removed every 4 seconds.

Refer to Figure H-3, VSWR Logic Timing Diagram, for the following discussion.

When the VSWR PAL receives more than one Antenna VSWR trip signal from the one-shot, the PAL will continually count the number of trips.

a. If only two trips occur as shown on the left side of the drawing, the Blink output will only go high for 4 seconds, and 8 seconds after the last Antenna VSWR pulse, the counter will be reset to zero.

b. If four trips occur as shown in the center of the drawing, the counter will count up to four and begin counting down again if no additional trips occur.

c. The right side of the drawing shows that if the counter is set to two and three more trips are registered, the Antenna VSWR output goes high for 250uS.

When Antenna VSWR goes high, TP34 Antenna VSWR Foldback goes low and generates a 250uS Antenna VSWR-L at J6-1.

a. This will cause the Controller to foldback the power level by one increment (0.5 dB is the first increment) and latch the Antenna VSWR and Analog Input Power Foldback LED's on the Control front panel RED.

b. If five more VSWR trips occur, the power output reduced by additional steps.

Operation for Network VSWR is the same, except the output is at J6-5.

Refer to the Controller Section for more information concerning the foldback levels and recovery time.

H.6.11 VSWR Self Test

The VSWR Self Test logic circuits are located on the Controller and Output Monitor board. The Controller generates a VSWR Test Request-L pulse, whenever any of these conditions occurs:

a. The transmitter is turned on at any power level.

b. The power level is changed. For example, LOW to MED or MED to HIGH.

c. The VSWR TEST push-button on the LED board is depressed.

H.6.11.1 Successful VSWR Test

On the Output Monitor board, the incoming VSWR Test Request-L pulse at J6 performs the following:

a. Both VSWR Test Circuits Drivers pull the inverting inputs of both VSWR Comparators high, simulating VSWR faults.

b. U11-4 goes logic high, which triggers the 4 Second Timer and activates the Blink output to turn the VSWR Test LED RED.

c. Inverter U14-2 goes logic high and forms a pullup supply for Q46 via CR154. This allows a Network VSWR fault to be generated at the same time as an Antenna VSWR fault.

d. If the VSWR PAL receives both the Antenna and Output Network input signals within the 4 Second Timeout pulse, the Blink signal is released after four seconds and the VSWR Test LED returns back to GREEN. This is the indication that a successful VSWR Test has been performed.

H.6.11.2 Unsuccessful VSWR Test

a. If the VSWR PAL does not detect both VSWR trips before the Timeout, the Latch output will go high and remain high. This will latch the VSWR Test Status LED RED to indicate that the test failed.

NOTE

The only way to clear the LED is to pass a successful test.

H.6.11.3 Testing The VSWR Test Circuit

A method of testing the VSWR Self Test logic is as follows:

a. Press and hold the VSWR Inhibit switch S21 on the Output Monitor.

b. Press the VSWR Self Test push-button on LED board.

c. After 4 Seconds, the VSWR Self Test LED should remain RED.

d. Release the VSWR Inhibit and press the Self Test again.

e. After 4 Seconds, the VSWR Self Test LED should return to GREEN.

H.6.12 Manual VSWR Trip

Manual VSWR Trip push-button switches are available on the Output Monitor board to test VSWR trip comparators and VSWR fault counting logic. Switch S11 is a manual trip for the Antenna VSWR logic, and switch S4 is a manual trip for the Network VSWR logic. Each switch simulates a VSWR by grounding one side of the detector transformer. This causes current to flow through transformer which is rectified into a positive DC voltage

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which trips the comparator thereby simulating a VSWR condition. Upon transmitter foldback to extremely low power levels, these switches have no effect because the samples have been lowered enough not to trip the detectors.

H.6.13 VSWR Inhibit

Push-button switch S21 shunts the inputs of the VSWR Comparators to ground through diodes. This keeps the VSWR Comparators from being able to detect a VSWR fault. It should only be used when testing the VSWR Self Test.

H.6.14 Directional Coupler

The Directional Coupler, like the VSWR Detectors, depends on phase and amplitude relationships of voltage and current samples to provide a dc output voltage. In the Directional Coupler, the current and voltage samples are applied to opposite ends of a diode.

H.6.14.1 Forward Power

For forward power, the current and voltage samples are 180° out of phase with each other. The voltage across the diode and corresponding dc current output depends on the magnitude of the samples. As RF power output is raised, the sample voltages increase and the dc output becomes greater.

Jumper plugs JP4 and JP5 allow reversing the current sample phase so that the forward coupler reads “reflected power” and the coupler can be balanced by adjustment of the Forward Balance capacitors.

Diode CR41 is the forward power coupler’s diode. An RF choke and capacitor form a filter to remove the RF component, while a resistor and capacitor create a low-pass filter to remove audio-frequency variations due to modulation from the coupler’s output.

The voltage follower U9 drives the Forward Power Meter on Switch Board/Meter Panel and the Remote Metering amplifier on the External Interface board. The Forward Power calibration adjustment is located on the Switch Board/Meter Panel.

H.6.14.2 Reflected Power

The reflected coupler operates in the same way as the forward coupler, except that the samples are in phase with each other. When sample amplitudes are the same, no voltage appears across the diode. No current will flow through the diode, and there will be no dc voltage at the output. When a VSWR fault occurs, the phase and/or voltage relationship at the ends of the diode change, so that current begins flowing through the diode and the output voltage will increase.

The voltage follower U9 drives the Reflected Power Meter on Switch Board/Meter Panel and the Remote Metering amplifier on the External Interface board. The Reflected Power calibration adjustment is located on the Switch Board/Meter Panel.

H.6.15 ARC Detectors

There are two detectors, a Lower ARC Detector and a Upper ARC Detector. Both detector outputs are treated exactly as a Output Network VSWR Fault.

H.6.15.1 Lower ARC Detector

The Lower ARC Detector 2A5 monitors the Bandpass Filter at the bottom of the Output Network. A photocell is connected from +15VDC to the input of a comparator. The Lower Detector Threshold control R60 sets the threshold voltage for the comparator. If an ARC occurs, the voltage at the (-) input will be greater that the (+) input and the output will go logic low. This inverted output is connected to the Network VSWR Test line that will trip the Output Network VSWR Comparator. This output will also latch the DS5 Lower ARC indicator RED for a visual indication, until manually reset by the ARC Fault Indicator Reset switch S22. If the cable at J9 is disconnected, a ground for the interlock is removed, and the fault will be generated.

H.6.15.2 Upper ARC Detector

The Upper ARC Detector 2A4 monitors the Pi Matching Network at the top of the Output Network. Two photocells are used because more ambient light enters from the top.

H.6.15.2.1 Reference Sensor

The reference sensor photocell output is connected to the input of differential amplifier U16. The Sensor Balance control R97 is used to adjust this voltage at TP15, ARC Reference.

H.6.15.2.2 ARC Sensor

The actual ARC sensor photocell output is also connected to the input of differential amplifier U16. This voltage can be measured at TP14, Upper ARC Sense.

H.6.15.2.3 Differential Amplifier

U16 is a differential amplifier that has the outputs of both sensors connected to its inputs. The Sensor Balance control is adjusted so that the reference sensor voltage is the same as the actual sensor output, and therefore the output of the differential amplifier, at TP25 ARC Level, will be 0VDC.

H.6.15.2.4 Compensated Comparator

Should an actual ARC occur, the output of the differential amplifier will increase and the voltage at the (-) input of the comparator will be greater than the (+) input, and the comparator output will go logic high. This output will perform the same functions as the Lower ARC Detector.

H.6.15.2.5 Absolute Comparator

If the amount of ambient light entering through the top of the Output Network is too great, ARC detection might not be possible. Under these conditions, an Absolute Comparator will generate the same fault.

H.6.16 Modulation Monitor Sample Equalization

The modulation monitor sample input at J3 is taken from a tapped inductor in the output network compartment. This input is buffered by U2 and connected to the Modulation Monitor Sample output at J4. A light dependent resistor (LDR) CR11 is connected from the buffer input to ground. The resistance of this device will change due to the AGC circuit from the Audio Demodulator, which will maintain a constant RF output over the entire frequency and power range of the transmitter. If the AGC function is undesirable or defective, the circuit may be bypassed, by moving JP1 from 1-2 to 2-3.

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NOTE

In the Bypass mode, the tap on the coil should be adjusted for the desired level of RF sample at the highest power level (normally 100 kW). Failure to do so might result in external monitoring equipment damage.

The modulation monitor should provide a 50-Ohm termination for the mod monitor sample output. It may be necessary to use a 50-Ohm termination at the monitor to meet this requirement.

H.6.17 Audio Demodulator

The primary of transformer T2 is also connected to the modulation monitor sample at J4. Full wave rectifiers demodulate the amplitude modulated secondary windings of the transformer. Carrier filter capacitors leave TP22 with a recovered audio signal. A direct coupled unbalanced to balanced amplifier provides Demod Audio (+) and Demod Audio (-) at J6. This balanced signal is connected to the External Interface via traces on the Transmitter Interface.

H.6.18 Modulation Monitor Sample Equalization

A sample of the Demod Audio (+) is connected to an active high pass filter that will remove the audio component while passing a dc voltage proportional to the carrier level. This output becomes one input to a comparator that drives transistor Q19. The other input of the comparator is an adjustable positive dc voltage that is set by R172 AGC. The output of the comparator controls the conduction of the transistor, which varies the voltage applied to the LED internal to the LDR. When the AGC voltage is set, the LDR will maintain a constant RF output at J4.

H.6.19 Air Flow Monitoring

The Air Flow sense circuitry is used to monitor the air flow in the Output Network Cabinet. Air flow Monitor 2A3 is connected to the Output Monitor at J7.

For a circuit description of the Air Flow Monitor refer to the Modulation Encoder Section, Onboard Air Flow Monitor.

When the transmitter is turned on, the TX Enable-H will turn on a transistor and supply B+ to the Air Flow Monitor.

The incoming Air Flow voltage is applied to amplifier U4 with an adjustable gain control R58, Air Flow Calibration. The voltage at TP8 Air is fed to the (+) inputs of two comparators.

The cable connecting the Air Flow Monitor presents J7-7 Interlock with +5 VDC and establishes voltages at the (-) inputs of the comparator through a voltage divider network.

If airflow in the Output Network Cabinet is reduced, the voltage at TP8 will eventually be greater than the reference and the comparator output will go logic high. Transistors are turned on illuminating DS1 Air Flow Fault RED and sending an Air Reduced-L low signal at J6 to the Controller. If TP8 continues to rise, an Air Flow Fault-L low will turn the Transmitter OFF.

H.6.20 Power Supplies

DC supply inputs from the low voltage power supply to the board are +22VDC, +8VDC, and -22VDC, and are regulated to +15VDC, +5VDC, and -15VDC using regulators U23, U24, U25, and U26. Each input is fused, with 2A fuses F1, F2 and F3. The output of the regulators are transient protected by zeners.

H.6.20.1 Power Supply Fault Sensing

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +22VDC supply goes to R199 and CR175 and +8VDC goes through CR176 to a 5 volt regulator, U28. This +5 Volts is designated B+ and can be measured at TP40.

The B+ is used as a reference to inputs of comparator U22 through a series voltage divider network. Each supply is connected to a voltage divider and then connected to the other inputs of the comparator. With the non-inverting inputs more positive than the inverting inputs the comparator output is a logic high. This is the NORMAL condition with no faults.

If one of the regulated supplies fails or drops low by more than 20%, the corresponding comparator output will go logic low. DS9 Supply Fault will be illuminated RED and the Supply Fault output at J6 will be logic low.

This will cause the transmitter to apply an RF Mute, and the Output Monitor Supply Fault LED on the Control front panel will be illuminated RED.

H.7 Troubleshooting the Output Monitor Board

The circuitry contained on this board can be classified into the following sections:

a. Power Supply.
b. VSWR Sensing.
c. Airflow monitor.
d. Power Metering.
e. Monitor Equalization.
f. Audio Demodulator.

Refer to the proper section for the circuit being addressed.

H.7.1 Power Supply

If an Output Monitor supply fault is displayed on the Control front panel, with only the low voltage on, check the LED indicators on the Output Monitor:

DS10 (+15V)

DS12 (+5V)

DS11 (-15V)

Each of these LED indicators should be lit if the individual supplies are operating normally.

a. If DS9 is illuminated RED:
b. Use a multimeter to measure the +15VDC, +5VDC, and -15VDC power supplies.
c. If any supply voltage has been reduced by 20% or more:
   1. Check the input fuse and replace if necessary.

2. If the fuse is not open, measure the input TP for the unregulated voltage.
3. If the unregulated input is correct, replace the regulator.

d. If all supplies measure correct:
1. Check TP40 for +5VDC and replace U28 if necessary.
2. If TP40 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

H.7.2 Antenna VSWR

If the transmitter Control front panel displays an ANTENNA VSWR and ANALOG INPUT POWER FOLDBACK, check for an upscale reading on the ANT NULL position on the front panel multimeter when the transmitter is operating.

H.7.2.1 ANT NULL Reads Upscale

a. The first step is to verify that the Load for the transmitter is of the proper output impedance. It should be thoroughly checked and any problems repaired before troubleshooting the transmitter.

H.7.2.2 TP5 and TP6 not equal in Phase and/or Amplitude

Check that the relays and FETs for the corresponding switch closures are closed or ON as expected. Check that a 4V control voltage is being applied to the gate of the FETs, and that the drain is near zero volts for each FET where the corresponding switch is in an ON condition.

H.7.2.3 TP5 and TP6 matched in Phase and Amplitude

a. Check TP7 for a null or minimum signal (less than 0.5V p-p at 100kW carrier). The signal should be composed of only RF harmonics.
1. If the null is not present and both TP5 and TP6 are equal in phase and amplitude, check CR90, CR94 and T3.

b. If there is a DC level, check the cathode of CR7 for a logic high.
1. If present, refer to the Controller Section and troubleshoot the VSWR Test Request Line.

H.7.2.4 ANT NULL Reads Zero

a. Check for a logic high on U10-6.

b. If present check the voltage on TP21 and compare this to the Test data readings.
1. If the voltage on TP21 agrees with the Test Data replace U10.
2. If TP21 does not agree with the Test Data, check the voltage divider and replace U10.

H.7.2.5 ANT NULL Reads Zero, RF MUTE LED Illuminated Only

a. To verify that the RF mute is coming from this board, check TP30 for a logic high.
1. If TP30 is low, check Q48, Q51, and U18.
2. If TP30 is a logic high, check Q44, U18, and U13.

H.7.2.6 ANT NULL Reads Zero, VSWR, and Foldback Illuminated Only

If only these faults are displayed and return soon after the reset is pressed:

a. Start by checking U13-2, U13-13, and observe DS2.
1. If U13-2 is logic high and DS2 is not illuminated, replace U13.

b. U13-13 should be logic low when U13-2 is low, if not replace U13.

c. If U11-3 is logic low, and U11-23 is high, replace U11.

H.7.3 Output Network VSWR

The troubleshooting procedure is basically the same as the Antenna, with the exception of the ARC Detector input as a possible cause.

H.7.3.1 DS5 Lower ARC Illuminated RED

a. If it has been determined that no arcing is occurring in the Output Network, troubleshoot as follows:

b. Check that the cable is correctly inserted into J9.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

c. Check that the cable is correctly inserted into the 2A5 Lower ARC Detector board.

d. If the voltage at TP25 is not 0VDC, check the alignment of the Sensor Balance and replace U16 and the sensors if needed.

e. If TP25 is 0VDC, and the voltage at TP17 matches the factory test data, replace U6 and/or U19.

f. If the indicator can not be reset, replace U20.

H.7.3.2 DS4 Upper ARC Illuminated RED

a. If it has been determined that no arcing is occurring in the Output Network and the ambient light not above normal, troubleshoot as follows:

b. Check that the cable is correctly inserted into J9.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

c. Check that the cable is correctly inserted into the 2A4 Upper ARC Detector board.

d. Replace U6 if needed.

H.7.4 Power Metering

H.7.4.1 Forward Power

a. Check for a dc voltage at U9-5 with carrier only. This voltage should change as the power is raised or lowered.

b. If there is no DC or the level does not change, check CR41 anode for an RF signal.

1. If there is no RF signal refer to the Overall wiring diagram to trace the loss of signal.
2. If there is RF on CR41, check CR41, the other input diodes, and U9.

H.7.4.2 Reflected Power

a. Turn off the transmitter and put P4 and P5 in the Cal position.

b. Turn on the transmitter and check for a DC level at U9-3 with carrier only. This voltage should change as the power is raised or lowered.

c. If there is no DC or the level does not change, check CR45 anode for an RF signal.

1. If there is no RF signal refer to the Overall wiring diagram to trace the loss of signal.
2. If there is RF on CR45, check CR45, the other input diodes, and U9.

H.7.5 Air Flow Sensing

If the Control front panel displays an Air Reduced or Air Flow indication and DS1 is illuminated on this board:

a. If no air flow problem actually exists, begin troubleshooting by checking TP8 for a DC voltage less than 2.5VDC.

b. If TP8 is greater than 2.5 Volts check TP9 for less than 0.6VDC.

1. If TP9 is greater than 0.6 Volts troubleshoot the Air Flow Sensor board in the Output Network Compartment.
2. If TP9 is 0.6 Volts or less, check or replace U4.

c. If TP8 is 2.5VDC or less measure the voltage on U3-6. It should be approximately 3 Volts.

1. If the voltage is missing, suspect an open cable running to the Output Network Air Flow Sensor. Refer to the Overall wiring diagram to trace the cable.

d. If the voltage is correct, replace U3 and check Q45 and Q47 as needed.

H.7.6 Monitor Equalization

Failures of this circuit would be noticed as no modulation monitor level change as each power level is selected.

H.7.6.1 Incorrect Modulation Sample

a. If the modulation level is incorrect on J4, check for the presence of RF on J3. (This can be done by checking the center solder connection to ground since J3 is on the back side of the board.)

b. If RF is present on J3 but not J4, replace U2.

1. If there is no RF present on J3 refer to the overall wiring diagram to trace the cable to 2L3.

c. If RF is present on J3, measure the voltage across the LED inside the LDR when changing the power.

1. If the voltage changes, replace the LDR.
2. If the voltage does not change, replace U21 and check Q19.

H.7.7 Audio Demodulator

a. Begin by checking for the presence of RF on the cathode of CR54.

1. If RF is not present, check for a shorted T2 or a problem in the Modulation equalization circuit.

b. If RF is present on CR54, check TP22 for a clean audio signal.

1. If the signal is distorted check CR54, and CR83.

c. If the signal at TP22 is correct, check U9-8 and U9-14.

1. If the signal is incorrect, replace U9.

H.8 Removal and Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting hardware.

Carefully pull the board forward and unplug J1, J3, J7 and J9 from the back of the board.

When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches on the new board are set to the same positions as the jumpers on the original board.

H.9 Alignment

The following alignments should be done when the Output Monitor board has been replaced.

H.9.1 Antenna and Network VSWR Threshold

a. Measure the voltage on TP21, Antenna VSWR Threshold, and adjust R130 to the same as the recorded value from the factory test data sheet.

b. Measure the voltage on TP20, Network VSWR Threshold, and adjust R139 to the same as the recorded value from the factory test data sheet.

H.9.2 Upper And Lower ARC Detector Threshold

a. Measure the voltage on TP17, Upper ARC Threshold, and adjust R110 to the same as the recorded value from the factory test data sheet.

b. Measure the voltage on TP12, Lower ARC Threshold, and adjust R60 to the same as the recorded value from the factory test data sheet.

H.9.3 Sensor Balance

a. Adjust the Sensor Balance control R97 for minimum voltage at TP25, ARC Level.

WARNING: Disconnect primary power prior to servicing.

H.9.4 AGC

a. With the transmitter operating at 100kW, adjust R172 AGC for 6Vp-p of RF at J4.

H.9.5 Forward and Reflected Power Null Adjustments

a. With the transmitter operating at 440 to 460A of PA Current, select the Reflected power position on the front panel meter.
b. Adjust the Reflected Balance capacitor for each frequency, on the Output Monitor to null the meter indication to zero. C56 should be used for frequency 1, C57 for frequency 2, and C58 for frequency 3.
c. Depress the front panel OFF button to turn off the transmitter.
d. Move the jumper plugs of JP4 and JP5 from position 1-2, to position 1-3 on both plugs.
e. Turn the transmitter back on at 440 to 460A of PA Current. Note that the Reflected power meter position indicates forward power.
f. Move the Forward/Reflected meter switch to the Forward power position. Note that it now indicates reflected power.
g. For each frequency, adjust the forward balance capacitors to null out this indication to zero. For frequency 1, use C65, for frequency 2 use C62, and for frequency 3 use C63.
h. Depress the OFF button and move the jumpers on JP4 and JP5 back to position 1-2.
i. Forward and Reflected directional couplers are now nulled.

H.9.6 Air Flow Calibration

a. Verify that the following requirements have been satisfied:
   1. All fans are operational
   2. Air filters are clean
   3. There is no back pressure present from the exhaust system
b. Operate the transmitter at 100kW with normal program material.
c. Measure the DC voltage at TP8 on the Output Monitor board.
d. This voltage should be +2.5VDC. If it is not, adjust R30 Air Flow Calibration until the voltage at TP4 is +2.5VDC or the pot reaches the end of range.

WARNING: Disconnect primary power prior to servicing.

H.10 Output Sample Board

H.11 Introduction

This Section describes the Output Sample board. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

H.12 Location

The Output Sample board is located in the Output Network Cabinet toward the top of the compartment (SEE VIEW 19).

NOTE: Parts List for this board is in Section VII.

H.13 Function

The Output Sample board includes current sample and voltage sample circuits for VSWR fault phase angle detectors and the power meter's directional couplers.

H.14 Detailed Circuit Description

H.14.1 RF Current Samples

H.14.1.1 VSWR Phase Angle RF Current Sample

The current sample for the phase angle detector includes a current transformer, with the copper rod carrying the RF current as the primary, and a toroid or ferrite core inductor, T1, as the secondary. Resistors are connected across the secondary to load the winding and to convert the current sample in the secondary winding to a voltage sample for the phase angle detector.

H.14.1.2 Directional Coupler Current Sample

The current sample for the directional coupler comes from current transformer T2 on the Output Sample board. The current transformer's primary winding is the copper tube in the output network. Resistors R10 through R17 convert the current into two RF voltages, 180° out of phase with each other, and also load the winding to prevent the high voltages that would appear across the unloaded winding. The 2 voltages are used as the Forward and Reflected samples for the Directional Coupler.

H.14.2 RF Voltage Samples

H.14.2.1 Forward Voltage Sample

The Forward Voltage Sample is taken from a capacitive divider made up of capacitors, C7, C14, C11 AND C15. It is sent to the Output Monitor board via J1, and will be used for the Forward Power meter reading.

H.14.2.2 Reflected Voltage Sample

The Reflected Voltage Sample is taken from a capacitive divider made up of capacitors, C7, C13, C10 and C16. It is sent to the Output Monitor board via J1, and will be used for the Reflected Power meter reading.

H.14.2.3 Antenna VSWR Voltage Sample

The Antenna VSWR Voltage Sample is taken from a capacitive divider made up of capacitors, C7, C12, C9 and C17. It is sent to the Output Monitor board, via J1-11, where it will be used by the Antenna VSWR Sense circuit.

H.14.2.4 Network Voltage Sample

The Network Voltage Sample is taken from a Capacitive voltage divider made up of C7, C8, and C9, all three of which are attached to the RF input of the Output Network, and another C8, which is on the Output Sample board. It is sent to the Output Monitor board, via J2 where it will be used as part of the Network VSWR Sense circuits.

H.15 Troubleshooting

Troubleshooting this board would mainly involve a visual inspection looking for a cracked toroid, open or broken capacitor, or a loose connection.

H.16 Removal and Replacement

WARNING

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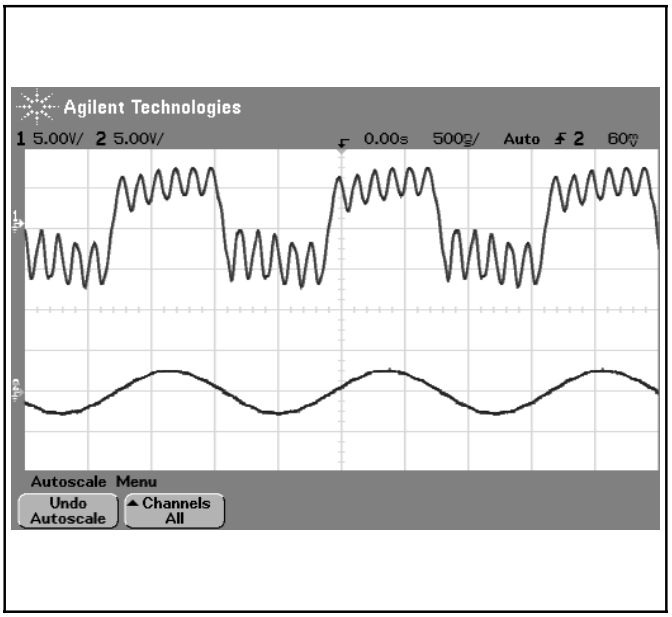
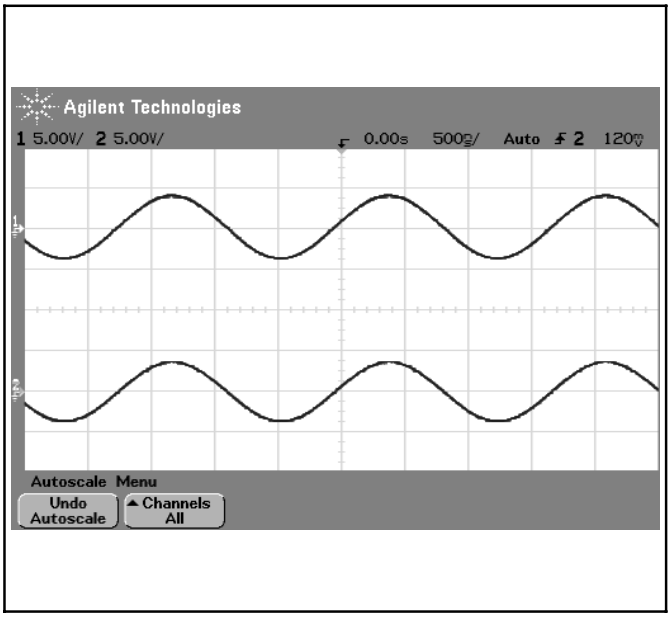
a. Remove the connectors.
b. Remove the copper tube running through the Sample board.
c. Remove the 4 mounting screws. Reverse this procedure for installing the replacement.

H.17 Alignments

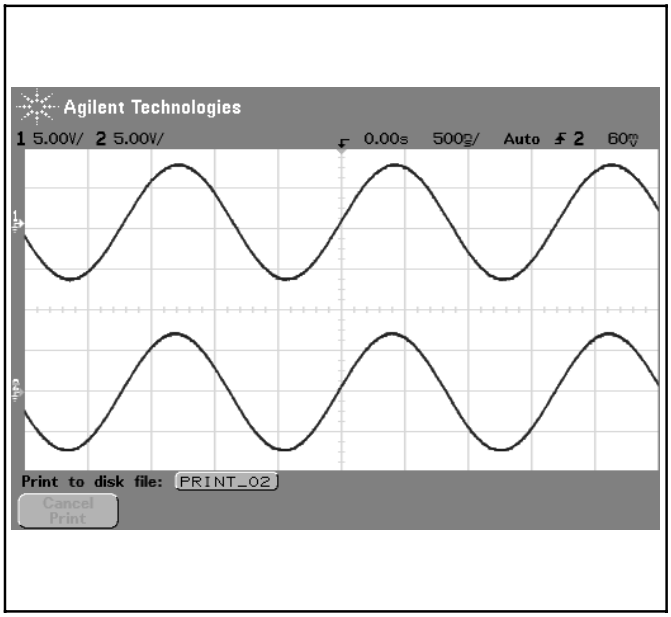
There are no alignments available on this board.



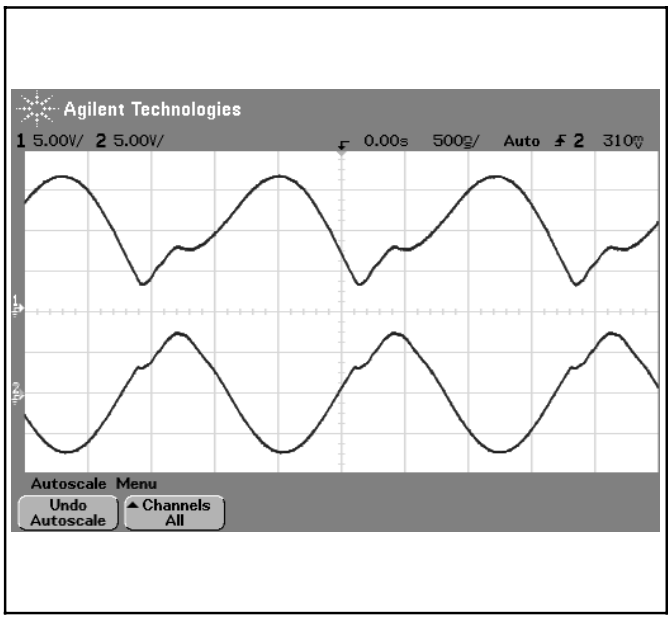
CH1 TP3
CH2 TP2



CH1 TP6
CH2 TP5

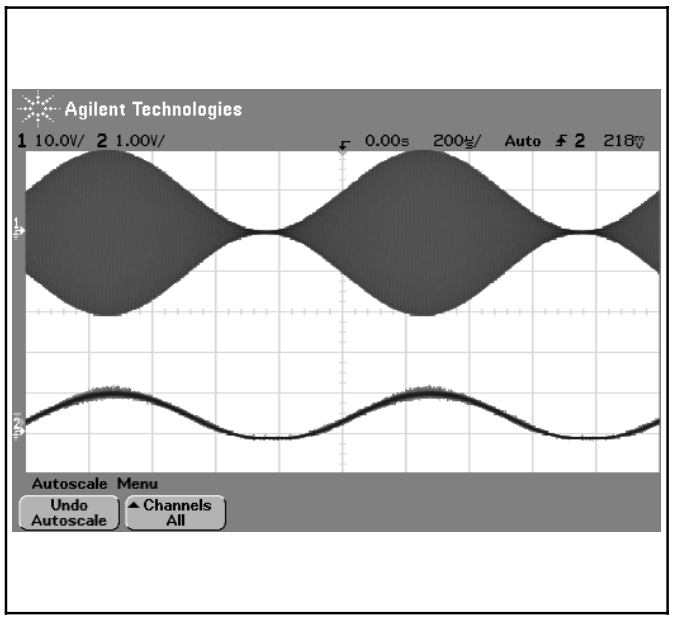


CH1 J1-15
CH2 J1-5

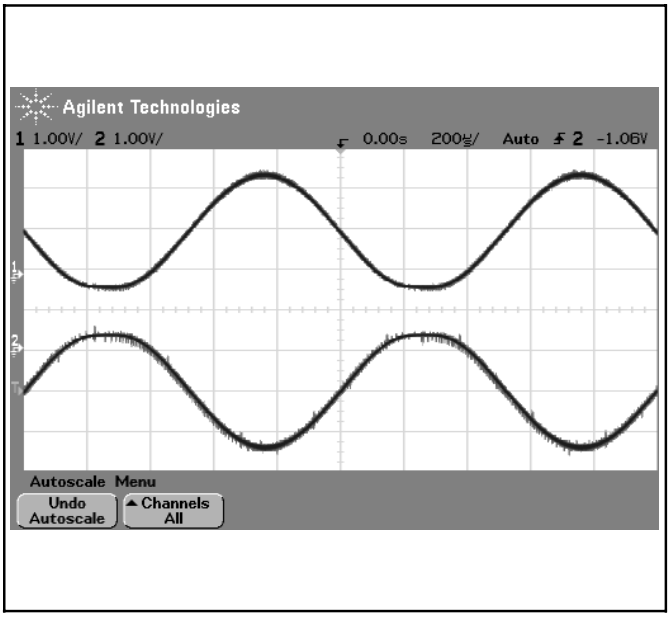


CH1 J1-13
CH2 J1-3

WARNING: Disconnect primary power prior to servicing.



CH1 J4
CH2 TP22



CH1 J6-33
CH2 J6-31

WARNING: Disconnect primary power prior to servicing.

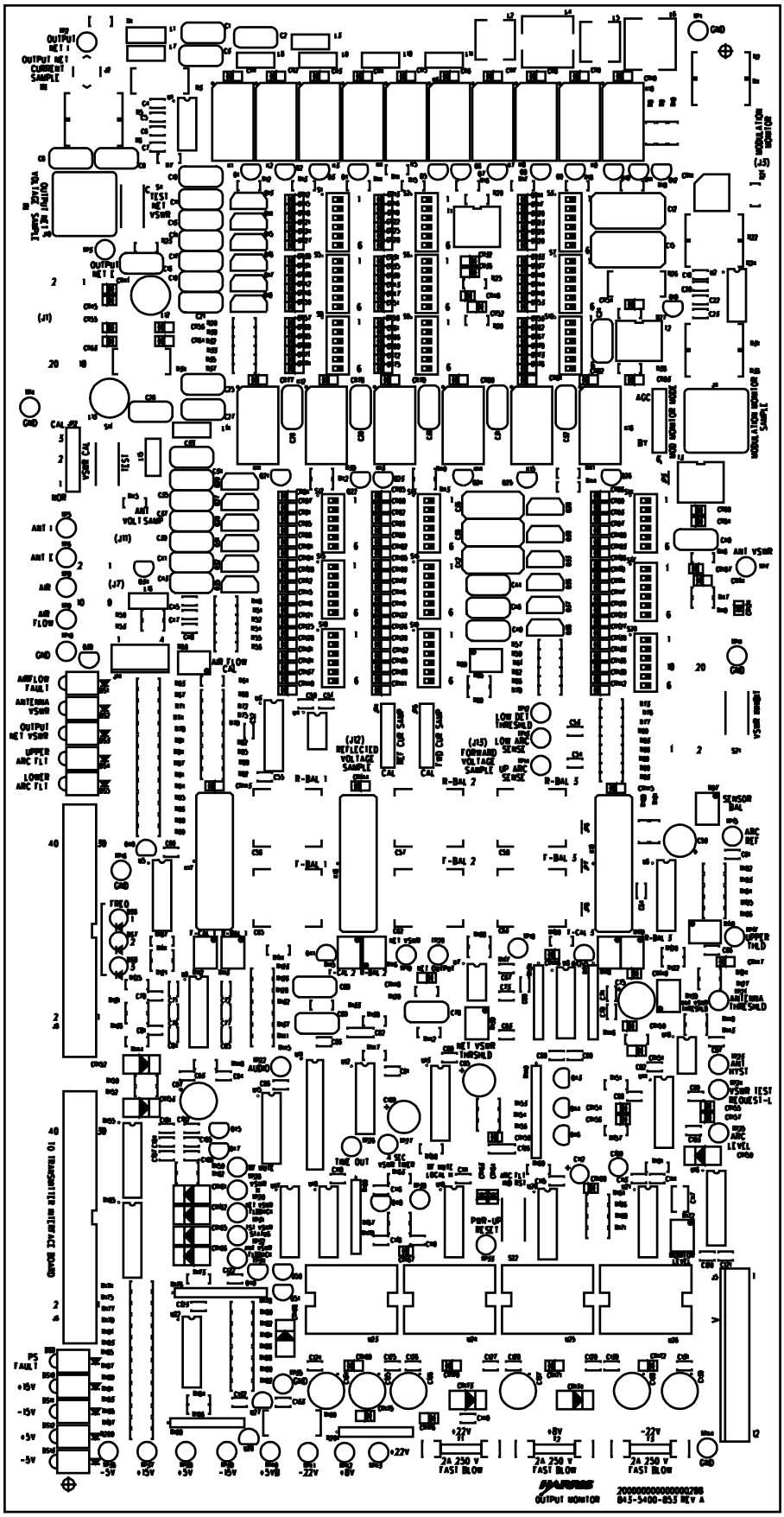


Figure H-4. Output Monitor Component Locator

WARNING: Disconnect primary power prior to servicing.

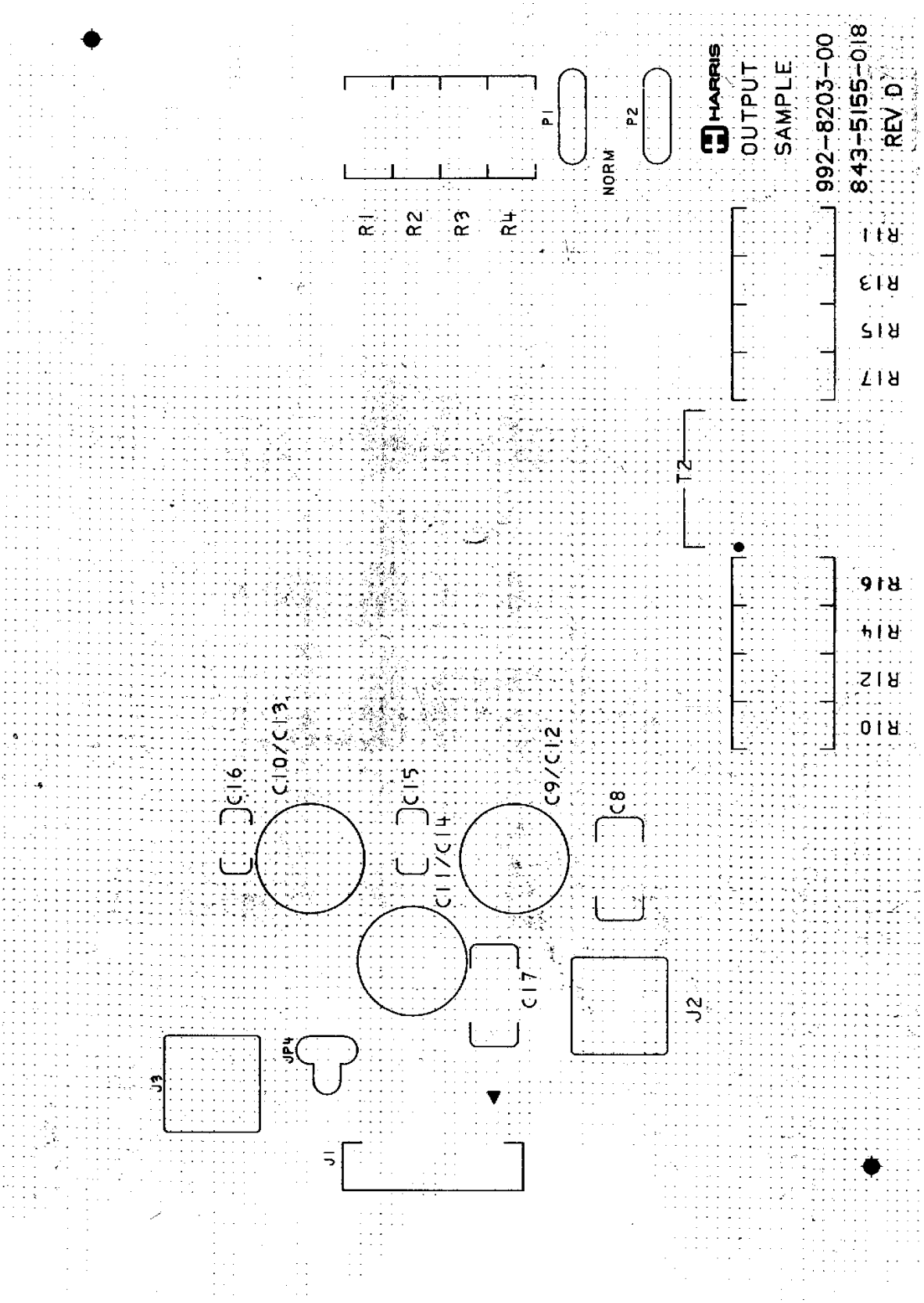


Figure H-5. Output Sample Component Locator

WARNING: Disconnect primary power prior to servicing.

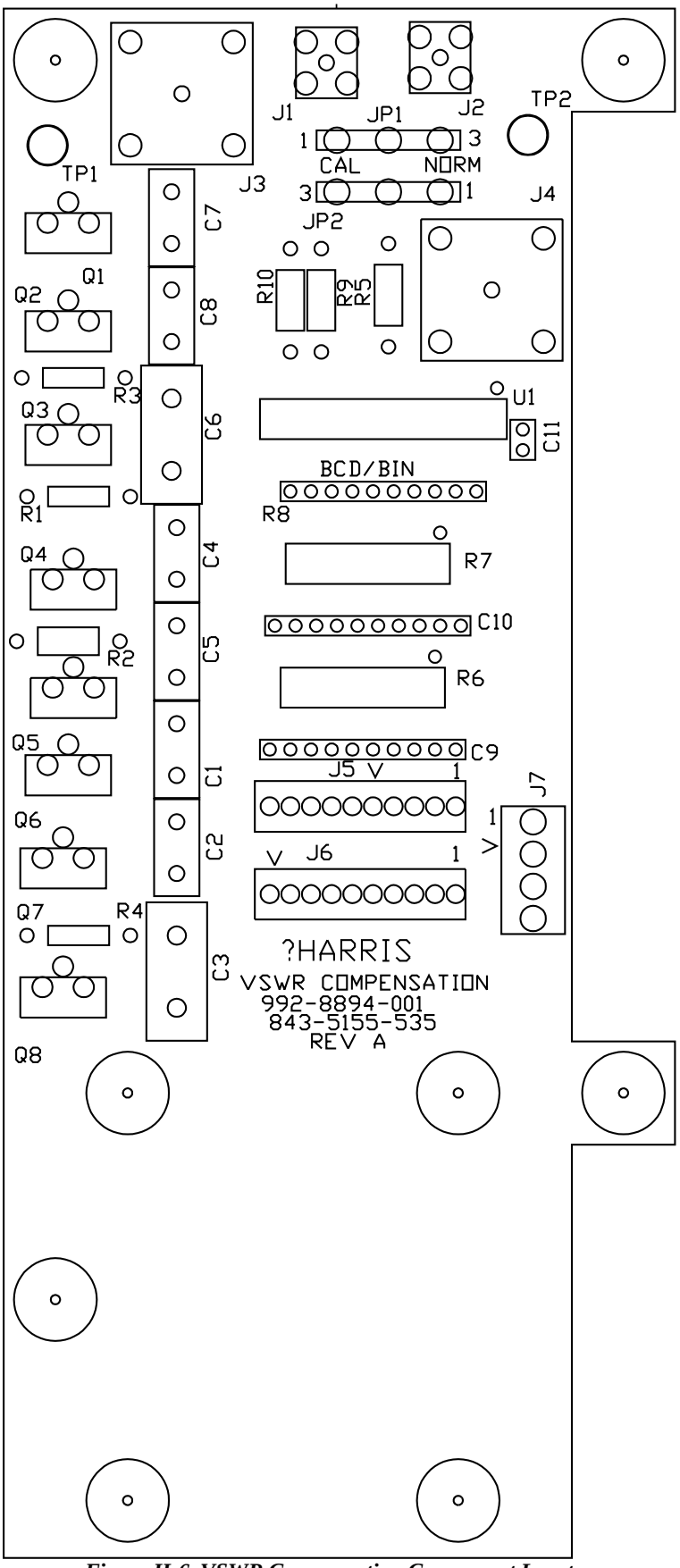


Figure H-6. VSWR Compensation Component Locator

WARNING: Disconnect primary power prior to servicing.

J.1 Introduction

This section describes the Analog Input board. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, and Removal/Replacement and Oscilloscope plots of key points.

NOTE: Parts List for this board is in Section VII.

J.2 Function

The Analog Input board includes an audio input amplifier, power control adjustments, circuits for optimizing audio performance, and +230VDC current overload and monitoring. The output signal from this board is an audio signal with a DC component, which goes to the A/D Converter board. The DC component determines the transmitter's unmodulated or carrier power output, and the audio component changes the instantaneous power output.

J.3 Location

The Analog Input board is located in the center PA cabinet, on the back of the front door. (SEE VIEW 13)

J.4 Oscilloscope Waveform Plots

Actual oscilloscope waveform plots of key troubleshooting points are located at the end of this section. All plots were taken at 100 kW with 100% 1 kHz modulation at 540 kHz carrier frequency, unless otherwise noted.

J.5 Block Diagram Description

J.5.1 Audio Flow

The audio input signal passes through a Bessel filter to the transformerless Balanced To Unbalanced Amplifier.

An (Audio + DC) Power Level Summer adds a negative DC offset that sets the maximum unmodulated carrier power level.

A +230VDC power supply sample correction voltage is processed by the Correction Signal Processor and is sent to the Correction/Overload Summing Amplifier to improve low frequency distortion. This signal is added to the (Audio + DC) signal in the Power Supply Correction circuit to correct for changes in the power supply voltage in order to maintain a constant carrier level.

Power Foldback is accomplished by a resistive attenuator which will reduce the (Audio + DC) signal should the carrier level need to be reduced due to VSWR or other faults.

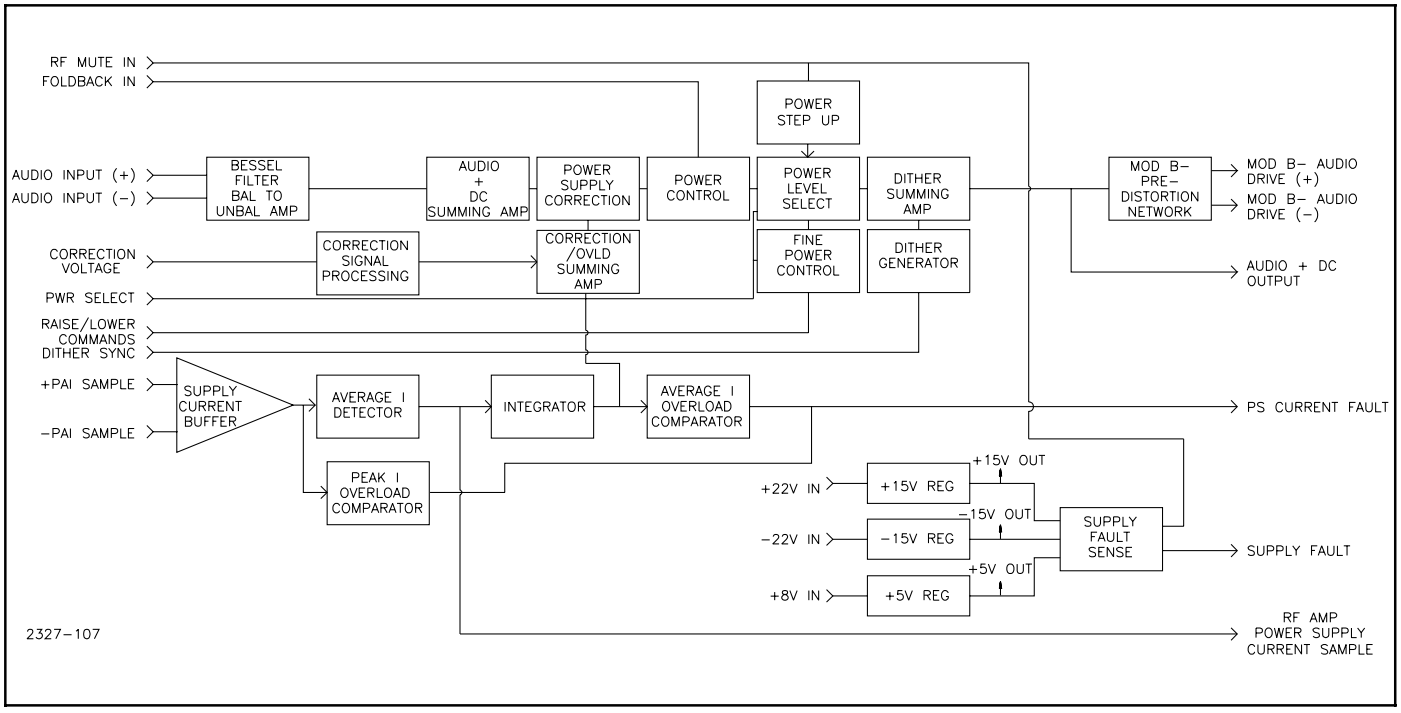


Figure J-1. Analog Input Block Diagram

WARNING: Disconnect primary power prior to servicing.

Power control attenuates or increases the (Audio + DC) signal to provide High, Medium and Low power output.

Fine Power Control will raise or lower the (Audio + DC) by plus or minus 10% of the current power level.

Any time the transmitter is turned ON, the current power level is changed to HIGH, MED, or LOW, or when an RF Mute is applied, the Power Step Up will hold the power level to one quarter of the current power level for one second then allow the power to come up to full current power level (via the Ramp-Up circuitry) after the RF Mute is removed.

A 72 kHz triangle wave signal from the Dither Generator controlled by the Dither Sync signal is added to the (Audio + DC) signal in the Dither Summing amplifier to improve transmitter signal to noise ratio (S/N).

The output from the Dither Summing amplifier is applied to the A/D Converter board and is also applied to the Mod B- Predistortion Network. This network will process the (Audio + DC) signal such that it will be ready to drive each Modulation Encoder with a balanced Mod B- Audio Drive.

J.5.2 +230VDC Current Monitoring

A sample of the voltage across the +230VDC power supply current shunt is amplified by the Supply Current Buffer and fed to an Average I Detector and a Peak I Overload Comparator.

The output of the Average I Detector is sent to the External Interface board for the Remote +230VDC Supply Current Sample and is also applied to an Integrator. The Integrator further averages the current sample and sends a current limiting signal to the Correction/Overload Summing Amplifier if current limiting is required due to overmodulation. The output of the Integrator also feeds an Average I Overload Comparator.

Should the average or peak voltages across the shunt trip these comparators, a Power Supply Fault will be generated.

J.5.3 Power Supplies

+22VDC, -22VDC and +8VDC are regulated down to +15VDC, -15VDC and +5VDC respectively by separate regulators to power circuits on the board.

A Supply Fault Sense circuit monitors these supplies and will generate a Supply Fault for the Controller and an RF Mute which will drop the current power level to 0 kW until the fault is cleared.

J.6 Detailed Circuit Description

J.6.1 Audio Input

The audio input signal connection to the transmitter is made at TB1-1(+) and TB1-2(-) on the External Interface board. Back-to-back zener diodes on the External Interface board provide protection against transients and excessive voltage at the input. A shielded audio cable carries the audio to connector J1-19(+) and J1-17(-) on the Analog Input board. Jumpers P1 and P2 are used to select the correct input impedance for the audio source. Refer to the Installation Section for determining the proper termination.

J.6.1.1 Bessel Filter

The first circuit in the audio signal path is a Bessel Filter, using passive components L5 through L8, C20 through C23, and terminating resistors R49 and R50.

J.6.1.2 Input Coupling

The audio signal from the Bessel Filter is ac coupled to the input amplifier, through C26/C27 and C24/C25. Input Coupling jumpers P7 and P8 are normally connected 2-1. If they are jumpered 2-3, the audio input is directly coupled. Back-to-back zener diodes CR10 and CR9, and shunt resistors R51 and R52, provide additional overvoltage protection.

J.6.1.3 Balanced To Unbalanced Amplifier

The first section of the amplifier includes two non-inverting amplifiers with high-impedance inputs U1-5 and U1-2. Both non- inverting amplifiers have the same gain, which can be adjusted with Audio Gain Adjust control R54. This control allows audio input levels from -10 dBm to +10 dBm to be used. The second section of the amplifier is a differential amplifier U2-1, which has two balanced inputs at U2-2 and U2-3 and a single unbalanced output at U2-1.

J.6.2 (Audio + DC) Summation

The output of U2-1 goes through a voltage divider to the input of Buffer Amplifier U3-1. The audio input to the buffer amplifier can be observed at TP12. U3-7 is a summing amplifier, the (+) input is an adjustable negative voltage. The output at TP15 will be the audio signal with a negative DC component. The Maximum Power Adjust control R56, limits the highest power level obtainable to 110 kW when the raise control is at maximum. This signal will be referred to as (Audio + DC) for discussion purposes.

J.6.3 Power Supply Correction

A Power Supply Correction circuit compensates for power supply variations. The (Audio + DC) signal from U3-7 is the Z input of multiplexer, U16 at pin 6, and the correction voltage sample is the X input. If the +230VDC supply sags, the power supply sample decreases slightly, and the (Audio + DC) output of U16-4 at TP11 increases to compensate.

J.6.3.1 Correction Voltage Sample

The Correction Voltage at J1-9 is determined by the Supply Voltage Sample Divider sample on Fuse board A39, and is connected to JP5. When JP5 is in the NORMAL position the Correction Input Sample, at TP28, is applied to a DC amplifier U27-2 and an AC amplifier U27- 9.

The DC Amplifier has fixed gain, and there will be a negative DC voltage at the output pin 1. This voltage is normally -5.5VDC and changes with the incoming Correction Voltage.

The AC amplifier is a low pass filter with adjustable gain. At low modulation frequencies (30Hz), the output at pin 8 has a small audio component of less that 1Vp-p with no DC offset. At higher modulation frequencies, the audio component is less due to the rolloff characteristics of the amplifier. The AC amplifier has an

WARNING: Disconnect primary power prior to servicing.

adjustable gain control R143 Low Frequency THD Null, this control is adjusted to improve low frequency distortion.

The outputs of the DC amplifier and the AC amplifier are combined and applied to U27-13. A current limit voltage is also added to U27-13 and will be discussed later. U27-14 is a buffer amplifier, its output is the correction voltage and goes to input X1 of multiplexer U16.

This circuit induces a Pre-Distortion component to cancel any power supply ripple or hum and power supply variations caused by the lower frequency modulation signals. The 100K variable resistor R29 (THD Null) may be adjusted for minimum output distortion.

J.6.3.1.1 Power Up Circuit

Diodes CR12 and CR13, capacitor C39, and the resistive voltage divider comprised of R61 and R62 form a power up circuit such that when supply voltage is applied U16 will properly respond to the Correction signal.

J.6.4 Differential Amplifier

The output of the power supply correction divider U16-4 is buffered by a section of U4. R64 connects this signal to Foldback through R10-6 and sends the signal to the (+) input of differential amplifier U4-5. The (-) input of the differential amplifier U4-6 is connected to P6-2.

The Power Step Up and Foldback circuits are connected to the (+) input at U4-5. The Fine Power Control circuit is normally connected to the (-) input at P6-3.

The purpose of the differential amplifier U4-7 is to amplify the difference between the (+) input and the (-) input to allow the three functions described above.

J.6.5 Foldback

Power levels upon startup and during any foldback series of commands are controlled using resistive attenuation of the Audio + DC. This is accomplished using U12 and resistors R69 through R75. Switch U12 is given binary instructions (FBOUT1, 2 & 3) and it in turn connects one of the above resistors to R64. This gives another path for the (Audio + DC) to ground and controls the level of (Audio + DC) that reaches the input of U4-5 (Power Control).

U5 (Foldback Comparator) receives 3 sets of inputs; Master Foldback, Internal Foldback and Ramp.

NOTE: Master Foldback inputs Bits 1, 2 & 3 are not used in this configuration so they are always low.

This Comparator determines which request is greater and feeds that to FBOUT1, 2 & 3 which is in turn fed to U12, discussed in previous paragraph.

In the normal on-air non-foldback condition, DB1, DB2 and DB3 are all low, as are RAMP1, RAMP2 and RAMP3 and the switch is not connected, effectively an open circuit. If the Controller has determined that the transmitter should be in foldback -.5 dB, DB1 (J2-17) will go high (+5VDC). Level Shifters U25-2 and U14-2 will convert the +5vDC to a high (+15VDC) and the switch will be connected from U12-3 to U12-14. This connects R69 and the voltage divider action reduces the power to 89 kW. The following chart lists the Foldback steps and power levels.

Foldback Level	DB1	DB2	DB3	U12-3 connected to	Power
0 dB	L	L	L	U12-13	100 kW
-0.5 dB	H	L	L	U12-14	89 kW
-1.0 dB	H	H	L	U12-12	79 kW
-2.0 dB	L	H	L	U12-15	63 kW
-3.0 dB	L	H	H	U12-2	50 kW
-6.0 dB	H	H	H	U12-4	25 kW
-10.0 dB	H	L	H	U12-5	10 kW
-12.0 dB	L	L	H	U12-1	6 kW

J.6.6 Power Ramp Up

Ramp up is the process of starting the transmitter at a relatively low power level and then advancing the power level (in steps) to full power. The rate of the steps (and therefore the time required to come to full power) is adjustable by using Jumper JP9.

The 16 Hz clock comes into U5 at Pin 1. JP9 is a three position jumper set. The three positions are Fast, Normal and Slow. The table below shows the approximate times for each setting of JP9:

Speed	JP9	Approx. Time
Fast	2-4	0.5 Seconds
Normal	3-4	2 Seconds
Slow	1-2	3 Seconds

This is fed to the clock input (pin 1) of U6, the Ramp PAL.

J.6.7 Fine Power Control

Fine Power Control allows the power output to be varied plus or minus 10 percent by using the Raise and Lower front panel controls which activate PAL U21, U20 or U19 depending upon the power level selected. The PAL's are programmed to act as up / down counters which send a digital word to the digital potentiometer. The Fine Power Controls are centered in its 3 ranges by placing S1 in the Calibrate position, and adjusting the three power levels for the desired output. R65 sets the HIGH power level, R67 sets MED, and R66 for LOW.

J.6.7.1 Digital Potentiometer

A signal from U4-1 is applied to buffer input U7-3 and is then fed to the input of a digital potentiometer U18-15. U18 is a digitally Controlled potentiometer. That is the value of the digital word on the input pins results in an attenuation of the signal on the output. The output of the digital potentiometer U18-1 is buffered by U7-7 and connected to P6-3. When P6 is in the NORMAL position, this signal is connected to the (-) input of differential amplifier U4-6.

When the resistance of the digital pot changes, the voltage at the (-) input of the differential amplifier varies and so does the output. U18 is controlled by the eight bit digital word DB0 (LSB)

WARNING: Disconnect primary power prior to servicing.

through DB7 (MSB) on the input pins U18-11 through U18-4 that comes from the Trim PALS.

When S1 is in the calibrate position and the unmodulated power output is set to 100 kW, the voltage U4-7 is 1.47VDC and U4-6 is - .64VDC.

If S1 is returned to the Normal position and the Raise control is depressed and held until the power output is 110 kW, the voltage at U4-7 is 1.54VDC and U7-7 is -1.28VDC.

If the Lower control is depressed and held until the power output is 90 kW, the voltage at U4-7 is 1.40VDC and U7-7 is 0VDC.

J.6.7.2 Trim PALS

The eight bit digital word for the digital pot is supplied by the Trim PALS. They basically function as Up/Down counters with a reset to center range control. Each PAL has the same program. U21 is used for HIGH power, U20 for MED, and U19 for LOW. The operation of each PAL is the same, so only High power PAL U21 will be discussed.

When the transmitter is on at the HIGH power level, J2-27 receives a high signal from the Controller. This signal is sent to U21-6 and activates the PAL, at this time U20 and U19 are inactive.

When the Raise control is depressed, J2-15 receives a high signal from the Controller. This signal is sent to U21-4 and the PAL begins to count up in binary fashion until U21-14 through U21-21 are all high. At this point the power output should be 110 kW and the upper limit of the Fine Power Control has been reached.

When the Lower control is depressed, J2-13 receives a high signal from the Controller. This signal is sent to U21-5 and the PAL begins to count down in binary fashion until U21-14 through U21-21 are all low. At this point the power output should be 90 kW and the lower limit has been reached.

J.6.7.3 S1 Calibrate

When S1 is placed in the Calibrate position, U21-2 is grounded. This resets the PAL to the center range, regardless of previous Raise or Lower commands. U21-14 through U21-20 will be low and U21- 21 will be high, and the three power levels can be set.

When S1 is switched back to the normal position, U21 is still in the center range. The PAL can then respond to Raise or Lower controls.

J.6.7.4 Fine Power Control Bypass

If P6 is moved from 2-3 to 2-1, Fine Power Control is Bypassed. The previous differential amplifier U4-7 now becomes a non-inverting amplifier with the (-) input connected to ground through R164. Power Step Up and Foldback functions are still active.

Refer to the Emergency Operating Procedures Section VI - A for the bypass procedure.

J.6.8 Power Control

The output of the differential amplifier is normally connected through P4 2-3, to distribute the signal to three switches inside U17. The switch U17 is shown in the transmitter OFF condition.

When the transmitter is turned on at HIGH power, the Controller places a high (+5VDC) on J2-27. Level Shifters U25-12 and U14-12 convert the high to +15VDC at U17-11. This causes switch "A" to close, connecting U17-14 to U17-13. Potentiometer R65 HIGH is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

When the transmitter is turned on at MED power, the Controller places a high on J2-29. Level Shifters U25-10 and U14-10 apply a high at U17-10. This causes switch "B" to close, connecting U17-15 to U17-1. Potentiometer R67 MED is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

When the transmitter is turned on at LOW power, the Controller places a high on J2-31. Level Shifters U25-8 and U14-8 apply a high at U17-9. This causes switch "C" to close, connecting U17-4 to U17-3. Potentiometer R66 LOW is now part of a voltage divider along with R76. Clockwise rotation will raise power output and counter-clockwise rotation will lower power output.

J.6.8.1 Power Control Bypass

If P4 is moved to the Bypass position 2-1, the Bypass Power Level pot R68 remains in the voltage divider circuit regardless of the power level.

Refer to the Emergency Operating Procedures Section VI - A for the bypass procedure.

J.6.9 Output Amplifier

The output of the power control voltage divider is connected to the (-) input of Output Amplifier U8-2. Summed together with the (Audio + DC) is a small Dither signal on the (+) input U8-3. The output of U8-1 -(Audio + DC) is connected to J3-5 where it continues on to the A/D Converter board.

J.6.10 Modulated B- Drive

The output of U8-1 also is fed to the (+) input of amplifier U8 at pin 5. The (-) input of U8-6 is a positive voltage, adjustable with OFFSET control R104. The output of U8-7 is an audio signal with an adjustable DC offset. The signal passes through a Non-linearity circuit formed by several resistors and diodes. The purpose of this network is to reshape the waveform to control RF Amplifier turn on/off times on the Modulation Encoders.

When the -(Audio + DC) output of U8-7 is small (corresponding to a negative modulation peak), changes in the voltage result in roughly proportional changes in the voltage at the output.

As the -(Audio + DC) output becomes more negative (corresponding to a positive modulation peak), it is clipped more and more heavily and changes in the output of U8-7 result in much smaller changes in the voltage at the input to U10-6 and in the Modulated B- supply output voltage.

The output of the predistortion network is connected to single ended to balanced amplifiers at U10-6 and U10-3. This balanced output signal at U10-7 and U10-3 (J1-3 (+) and J1-1 (-)) goes to each Modulation Encoder where it modulates a negative supply to provide the Modulated B- Supply.

WARNING: Disconnect primary power prior to servicing.

J.6.11 Dither Circuits

The Dither signal optimizes noise performance in the transmitter by introducing a small 72 kHz triangle wave on the -(Audio + DC) signal

J.6.11.1 Dither Oscillator

The Dither Oscillator is made up of an integrator U9-8 and a square wave generator U9-1. The output of the Dither Oscillator at U9-8 is a triangle wave with an amplitude of 1 Vp-p. Dither Frequency Adjust, R19, sets the Dither frequency to a nominal 72 kHz. A voltage divider R25 and Dither Level Adjust potentiometer R26 reduces the Dither signal to a very low level at U8-3.

J.6.11.2 Dither Sync

A Dither Sync signal from A/D Converter on J3-8 is buffered by U9- 7. This signal synchronizes the Dither signal so that it increases just as the transmitter output switches from a condition where all Binary Steps are ON to the next step where a Big Step turns ON and all Binary Steps turn OFF. The A/D input is forced higher quickly enough to prevent switching back and forth between the two conditions.

When the transmitter output is decreasing, the dither signal is synchronized so that it is also decreasing just as the RF Amplifiers switche from a state with all Binary Steps OFF to the next step down, where a Big Step turns off and all the Binary Steps turn ON.

J.6.12 RF Mute

An RF MUTE signal from the Controller board or generated by the Analog Input board presents a low at J2-9. A low signal turns the RF Amplifiers off by inhibiting the Power Control switch U17 and the Digital Potentiometer U18. This action takes the Analog Input board's output to zero. When the RF Mute is lifted, the Power Step Up is activated.

J.6.13 Overcurrent Protection

Either a Peak Current Overload or an Average Current Overload will cause an RF Amplifier Current Fault.

U11-1 is a differential amplifier, which amplifies the voltage drop across +230VDC current shunt SH1. The signals from opposite ends of current shunt SH1 are routed to the differential amplifier inputs. The current shunt is between the negative side of the +230VDC Power Supply and ground. Zero Adjust resistor R35 is used to zero the output to the remote indicator under conditions of no RF Power being transmitted. The output of the differential amplifier U11-1 is connected to TP25 RF Amp Power Supply Current and applied to the peak and average current comparators.

J.6.13.1 Peak Current Overload

Comparator U13-1 senses peak current overloads. The comparator voltage reference is set by Peak Current Threshold control R113. The comparator has an open collector output which goes to +5 Volts through R162. Normally the comparator output is HIGH but if peak supply current exceeds the preset threshold the comparator output goes LOW. This sends an RF Amp Current Fault -L to the Controller via J2-5.

J.6.13.2 Average Current Overload And Supply Current Metering

Resistor R15 and capacitor C52 form a low-pass filter which removes audio frequency components from the supply current sample, so that only the average supply current remains at the output of voltage follower U11-14. The voltage follower output goes to U13-9 (input for current sensing) and provides a Remote RF Amp Supply Current output, at J1-5, to the External Interface for remote metering. This output may be "zeroed" by applying an RF Mute to the operating transmitter and adjusting R35 "Zero Adjust". R35, R33 and R34 make up an offset circuit for zeroing the sensed RF Amp Supply Current from the Controller.

The voltage follower also goes to the noninverting input of comparator U13-9. The comparator's inverting input is a reference voltage set by R118, the Average Current Threshold control. If the average current exceeds the preset threshold, the comparator output at U13-14 goes HIGH. C9 begins charging thru CR23 and as long as U13-14 remains high, the Current Limit voltage increases. This voltage is applied to two comparators and one amplifier. If the (-) input at U13-10 becomes greater than the (+) input, U13-13 goes low and illuminates Current Limit indicator DS5 RED.

Average current limiting is activated, producing a foldback signal at U27-7 that reduces the power output to keep the current at a safe level. Further increases in the voltage will cause U13- 2, and TP30 Current Fault, to go LOW. This sends an RF Amp Current Fault -L to the Controller via J2-5.

J.6.14 Power Supplies

DC supply inputs from the low voltage power supply to the Analog Input board are +22, -22 and +8 Volts, and are regulated to +15, - 15 and +5 Volts respectively using regulators U2, U22, and U23. Each input is fused, with 2A fuses F1, F2 and F3. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The output of the regulators are transient protected by zeners CR21, CR16, AND CR15.

J.6.14.1 Regulator Status

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a Supply voltage on the board that does not depend on the regulated supplies. The +22 Volt supply goes to R96 and CR20 and +8 Volts goes thru CR27 to a 5 Volt regulator, U29. This +5 Volts is designated +5VB.

The +5VB is used as the reference to the inverting input for comparator U15 thru a series voltage divider network. Each supply is connected to a voltage divider and then connected to the - inputs of U15. With the non-inverting inputs more positive than the inverting inputs the outputs of U15 are at +5 VDC. This is the NORMAL condition with no faults. This is also fed to the + input of the third comparator, U15-10, and (-) input is referenced at +2.5 VDC. In normal conditions, the output of U15-13 will be 0 VDC. If one of the regulated supplies fails or drops too low, the corresponding comparator output will go to 0 VDC and illuminate DS4 Supply Fault RED. This will cause output of U15-13 to go high and two commands are sent to the Controller.

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One is an RF MUTE at the collector of Q2 to turn all Big Step and Binary RF Amplifiers off. The other is a Supply Fault, when Q1 turns on, which shuts the transmitter OFF.

J.7 Troubleshooting

J.7.1 Power Supply

If an Analog Input supply fault is displayed on the Control front panel, then with only the low voltage on, check the LED indicators on the Analog Input board:

a. DS1 (+5V)
b. DS2 (-15V)
c. DS3 (+15V)

Each of these LED indicators should be Lit, if the individual supplies are operating normally.

J.7.1.1 DS4 Illuminated

DS4 will light under 2 basic conditions,

a. If any of the Low voltage supplies or regulators fail, or
b. If one of the regulated outputs is less than 80% of normal. This means that DS1, DS2, or DS3 could be lit and a supply fault still be detected, turning on DS4. The input supply voltages and the regulated supply voltages will have to be checked closely to determine why DS4 is lit.

J.7.1.2 No +5V (DS1 out)

a. If DS1 is not illuminated, check fuse F2 and replace if necessary.
b. If F2 is not open, measure TP18 for +8VDC.
c. If TP18 does measure +8VDC, replace U22.
d. If TP18 does not measure +8VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.3 No -15V (DS2 out)

a. If DS2 is not illuminated, check fuse F1 and replace if necessary.
b. If F1 is not open, measure TP17 for -22VDC.
c. If TP17 does measure -22VDC, replace U23.
d. If TP17 does not measure -22VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.4 No +15V (DS3 out)

a. If DS3 is not illuminated, check fuse F3 and replace if necessary.
b. If F3 is good, measure TP29 for +22VDC.
c. If TP29 does measure +22VDC, replace U24.
d. If TP29 does not measure +22VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

J.7.1.5 All LED Indicators lit (except DS4)

If all the LED indicators are lit, it is possible the fault sensing circuitry has failed. Procede as follows,

a. Check TP22 for +5VDC and replace U29 if necessary.
b. If TP22 is okay, measure the voltage on TP42.
c. If this is a logic high, the signal is correct and no fault exists on this board. Refer to the Controller section of the manual and to the transmitter overall wiring diagram to continue troubleshooting this fault.
d. If the TP42 is low, and TP19, TP20, and TP21 have the correct voltages, then troubleshoot U15 and associated circuitry and replace if necessary.

J.7.2 Audio Input

Problems in this circuit would be characterized by:

a. Poor high frequency Response, or
b. No audio with carrier present

J.7.3 Poor High Frequency Response

The circuitry that would effect this problem on the Analog Input board is the Bessel Filter.

a. Verify that P1 and P2 are in the correct position for the source impedance of the generator.
b. For more information on this, see the Installation section on setting Audio Source Impedance.
c. If the proper position is selected, check R39, R49, C20 thru C23 and L5 through L7.

J.7.4 No Audio but Normal Carrier is Present

a. Verify that audio is connected to the transmitter and P1 and P2 are in the correct position.
b. Check TP12 for an audio signal.
   1. If present, suspect U3.
   2. If the signal at TP12 is not symmetrical suspect U1.
   3. If it is not present, replace U1.

J.7.5 RF Amp Power Supply Current Fault

Several areas on this board could cause an RF Amplifier Power Supply Current Fault. These include:

a. Overcurrent Sensing
b. Max Power Adjust
c. Power Supply Correction

J.7.5.1 Overcurrent Sensing

If the Control front panel displays an RF Amp Power Supply Current fault, apply an RF Mute with S1 on Controller board and turn on the transmitter.

J.7.5.1.1 RF AMP Supply Fault Does Not Return

a. If the RF Amp supply fault does not return after the RF Mute is applied, check the voltage on TP23 and TP24 and compare them against the factory test data.
b. If they are not correct check R113 and R118.

WARNING: Disconnect primary power prior to servicing.

c. If these voltages are correct a true Supply Fault exists. Refer to the Transmitter Troubleshooting Section to locate the Supply fault.

J.7.5.1.2 RF Amp Supply Fault Returns

a. If the fault returns and the Supply current meter does not deflect upward, start troubleshooting by checking the voltage on TP30 of the analog input board.

b. If this is a logic high, the Analog Input board is not generating the fault. Refer to the Controller, Transmitter Interface Sections and Overall Wiring Diagram to track down the fault.

c. If TP30 is a logic low, check the voltages on TP23 and TP24 and compare them against the Factory test data.

d. If the voltage on either test point is different from the test data check R113, R118, U13 and the +15 Volt supply.

e. If TP23 and TP24 measure correctly, check TP4 for a logic high when the transmitter is turned on.

f. If TP4 is high, DS5 should also illuminate.

g. If TP4 is a logic high check TP25 for a voltage less than what was measured on TP23 when the transmitter is turned on.

h. If TP25 is greater than TP23 then, suspect a failed U11 or incorrect sample from the Controller.

i. If TP25 is less than TP23, measure the voltage on TP26 when the transmitter is turned on and compare it to the voltage on TP24.

j. If TP26 is higher than TP24 suspect a failed U11.

k. If TP26 is less than TP24, suspect a failed U13.

J.7.5.2 Max Power Adjust

If the fault is a true power supply current fault, and not a sensing problem, then there could be a problem with the DC level being added to the audio. Proceed as follows:

a. First, with the transmitter OFF, check the MAX POWER ADJUST circuit.

b. Measure TP15 for -1.15VDC (within 0.2VDC) with no audio. A voltage reading more negative than -1.35VDC would indicate a malfunction of U3 or a misadjustment of the MAX POWER ADJUST, R56.

c. If TP15 is too far off, measure TP14. It should measure one half of the voltage on TP15. If not, replace U3.

d. If TP15 is within range, move on to the Power Supply Correction circuit.

J.7.5.3 Power Supply Correction

a. If TP15 measures correctly, check TP11. It should measure -1.25VDC (within 0.2VDC).

b. If not, measure TP2. It should be approximately 0VDC.

c. If TP2 measures correctly, and TP11 does not, replace U16.

d. If TP11 and TP2 both measure correctly, then with the RF Mute ON, turn the transmitter on and measure TP2 again.

e. TP2 should measure approximately 5.6VDC.

f. If not, place jumper J5 in the Bypass position, 2-3, and again check TP2 for approximately 5.6VDC.

g. If present, refer to the overall wiring diagram to trace the missing correction voltage.

Note

If the sample is in the Bypass Mode, power level will not track changes in power line variances, and higher than normal low frequency THD may be noticed.

J.7.6 Power Control

Power control faults can be classed into four areas: Power Control, Fine Power Control, Power Step Up and Foldback. These areas all have an effect on the (Audio + DC) circuitry.

J.7.6.1 Power Control

If the transmitter appears "stuck" in one power mode even though the front panel indicators show a different power level has been selected:

a. Turn off the transmitter and move P4 to the Bypass position.

b. Turn the transmitter back on and adjust Bypass Power Level (R68) for the power output desired.

1. If R68 has no effect suspect U8 and or a fault on the A-D Converter board.
2. If the power can be changed by R68, turn off the transmitter and put P4 back in the normal position.

c. Turn on the transmitter and adjust the potentiometer on the Analog Input board R65, R67 or R66 for the selected power level.

d. If this has no effect on the power output, check the input of U17 for a high (+15V) on pins 9(Low), 10(Med),or 11(High) when a power level is selected.

e. If the high is present change U17.

f. If the high is not present when a power level is selected suspect U14 or U25.

J.7.6.2 Fine Power Control

a. If the fine power control (Raise, Lower function) does not operate on any power level suspect U18 or U7.

b. If the fine power control does not work at some power levels, suspect the PAL for that power level. (U21 for High, U20 for Medium and U19 for Low power.) These PALS have the same program and can be interchanged to verify that a PAL is defective.

J.7.6.3 Foldback

If the transmitter is in Foldback check the inputs to U25 at pins 1, 3, and 5 to verify that a fault with this board exists.

a. If any of these pins are a logic high a fault is being generated from the Controller. Refer to the Controller and Transmitter Troubleshooting Section to Continue.

b. If the inputs to U25 are low check TP36, TP35 and TP34 for a high of +15 VDC.

c. If any of these inputs are high suspect U25 or U14.

d. If the testpoints measure a logic low suspect U12.

WARNING: Disconnect primary power prior to servicing.

J.7.6.4 Modulated B-

If a Modulated B- problem occurs, use the plots and voltages from another Encoder to determine where the differences are. Also, verify the proper B- voltage from the test data sheets.

J.8 Removal and Replacement

Remove the 8 screws and 4 connectors from the board. When installing a replacement board, before operating the transmitter perform the Alignment for this board listed in this section of the manual.

J.9 Alignments

J.9.1 Audio Gain

J.9.1.1 Setting Audio Input Level

The Audio Input sensitivity of the transmitter can be adjusted with the AUDIO GAIN ADJ control on the Analog Input board, so that audio input levels of -10 Dbm to +10 dBm at 600 Ohms will produce 100% modulation. This is Factory set for +10dBm. If a level other than +10dBm is desired, use the following procedure to for this adjustment:

a. Set the Audio Generator for the desired audio level for 100% modulation. (Typical levels are 0 dBm or +8 dBm, but the transmitter can accommodate reference levels from -10 dBm to +10 dBm at 600 Ohms.)
b. Switch the transmitter to HIGH power.
c. Adjust the "Audio Gain Adjust" control (R54, on the Analog Input Board) so that modulation level is 100%, as read on the modulation monitor.
d. This completes audio input level adjustment.

J.9.2 Maximum Power Adjustment

a. Turn on the transmitter at HIGH power.
b. Set S1 to the Calibrate position.
c. Slowly adjust R65 fully CW or until the transmitter power reaches 110 kW.
d. Adjust the maximum power pot R56 for 100 kW. This will allow the transmitter to operate to 110 kW when the Fine Power adjustment is at maximum (+10%).
e. Switch to LOW power and adjust R37 until the desired Low power level is reached.
f. Switch to MEDIUM power and adjust R67 until the desired power level is reached.
g. Set S1 back to the Normal position.

J.9.3 Bypass Power Level Adjustment

a. Apply an RF Mute with S1 on the Controller and turn the transmitter on HIGH.
b. Move P4 from the Normal position of 2-3 to the Bypass position of 2-1.
c. Turn R68 Bypass Power Level fully counterclockwise.
d. Remove the RF Mute and adjust R68 to the desired power level.

NOTE

R68 can adjust the power level from 10 to 100 kW. If the power level needs to be changed while in the Bypass mode, it must be done manually by adjusting R68.

CAUTION

DO NOT SWITCH TO THE MEDIUM OR LOW POWER LEVELS - THE MODULATION MONITOR SAMPLE WILL BE MUCH HIGHER AND COULD POSSIBLY DAMAGE SOME EQUIPEMENT.

J.9.4 THD Null

Operate the transmitter at 100 kW and modulate using an IMD 4:1 signal. Adjust R29 for minimum IMD Distortion.

J.9.5 Low Frequency THD Null

Operate the transmitter at 100 kW, 95% modulation at a frequency between 30 and 60 Hz. If the low frequency THD is not acceptable readjust R134 for minimum.

J.9.6 Dither Frequency

Connect a frequency counter to TP1 on the Analog Input board and adjust R19 for 72 kHz. The frequency is not critical but should be within 70 to 74 kHz.

J.9.7 Dither Level

a. Modulate the transmitter at 100 kW with a 1 kHz sinewave to 95% negative peaks.
b. Set a reference level on the distortion analyzer from the demodulated audio out of the modulation monitor.
c. Turn the audio off and measure noise.
d. Adjust R26 on the Analog input board for minimum noise.

J.9.8 Modulated B- Adjustment

a. Modulate the transmitter at 100 kW with a 1 kHz sine wave at 95% negative peak modulation.
b. Connect a scope to TP27 MOD B- on the Analog Input board. Displayed will be the Modulated B- waveform.
c. Set the scope for 200mV per division, 500uS sweep, DC coupled and the 0.0VDC line on the top graticule, since this is a waveform at a negative voltage.
d. The positive peak of this waveform should be from -.5 to -.7VDC. The negative peak should occur between -1.5 and -1.6VDC.
e. The Offset adjustment R104 will affect the positive peak of the Modulated B- signal. When this control is fully CW the B- waveform will begin to flatten at the positive most portion and when then adjusted in a CCW direction, the flattening will decrease until it disappears and the B- will begin to become more negative going.
f. If the B- waveform is not within the range specified above adjust R130 B- Voltage Adjust per the Test Data Sheet. Use the Plots as a second option.

WARNING: Disconnect primary power prior to servicing.

J.9.9 Peak And Average Current Overload

a. Turn the Average current overload R17 fully CW.

b. Preset the Peak current overload R113 for 9.5VDC measured at TP23.

c. Operate the transmitter at 100kW and modulate with a 20Hz sinewave at 100% negative peaks.

d. Increase the audio level by 1.4 dB, PA current should be between 750 and 850 A.

e. Adjust the Peak current overload R113 until the current limit LED DS5 just begins to illuminate RED with modulation.

f. Reset the audio for 100% negative peaks.

g. Increase the audio by .5 dB and adjust the Average current overload R17 until DS5 just begins to illuminate RED.

h. Increase the audio in 1dB steps noting the PA current should not increase further than near full scale on the PA current meter.

i. Keep increasing audio level until the transmitter shuts off and recycles back on. If the audio level is not reduced, it may shut off and stay off at this time.

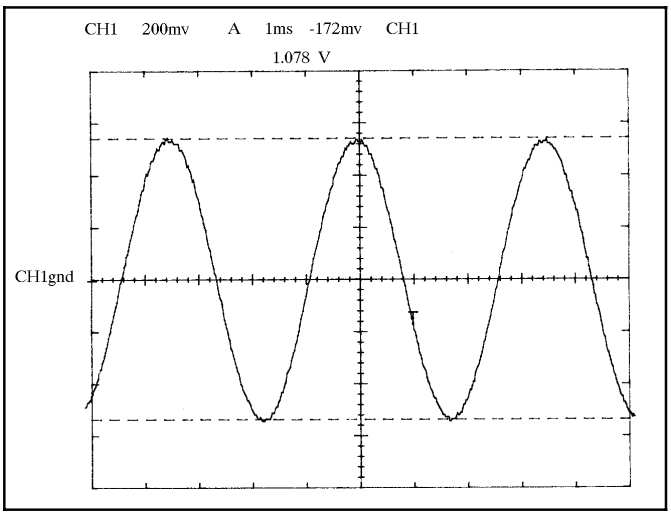
j. The Overcurrent LED will illuminate RED and can be reset from the LED panel.

k. Turn the transmitter back on and verify that the transmitter should take at least 10dB of audio overdrive before shutting off.

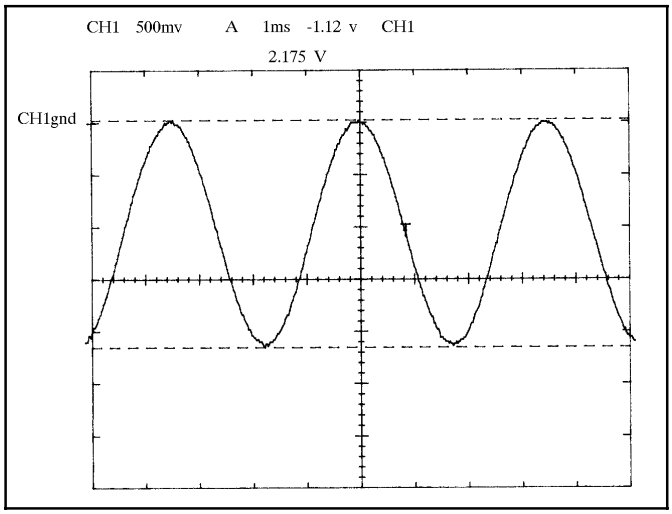
J.9.10 Zero Adjust

Operate the transmitter at 100 kW and apply an RF Mute. Adjust R35 Zero Adjust for a zero indication at the Remote Indicator.

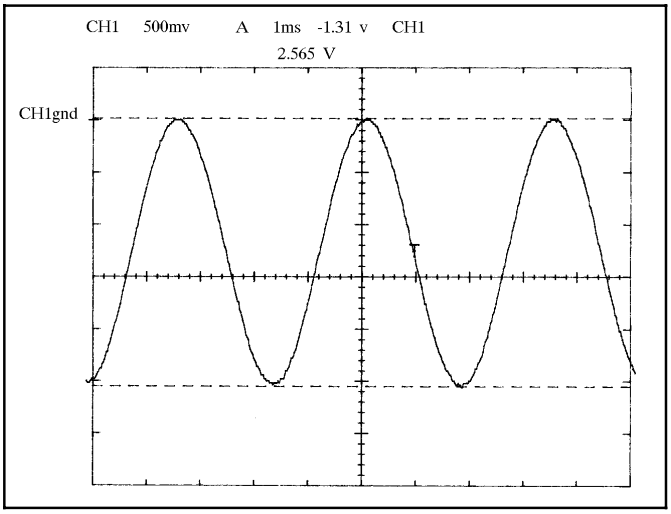
WARNING: Disconnect primary power prior to servicing.



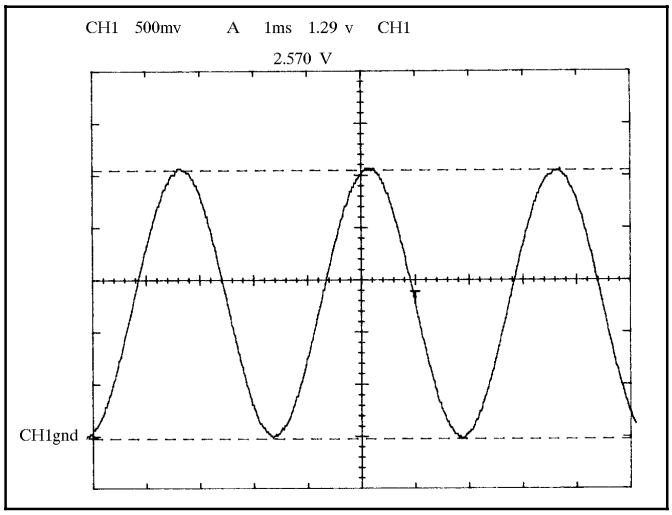
TP12



TP15

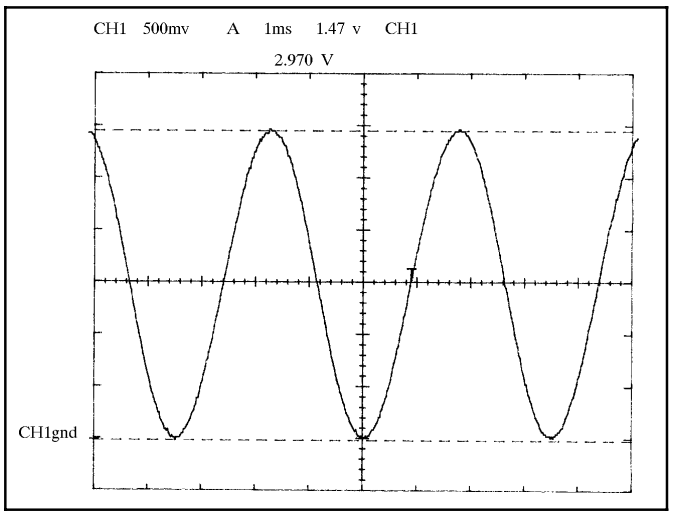


TP11

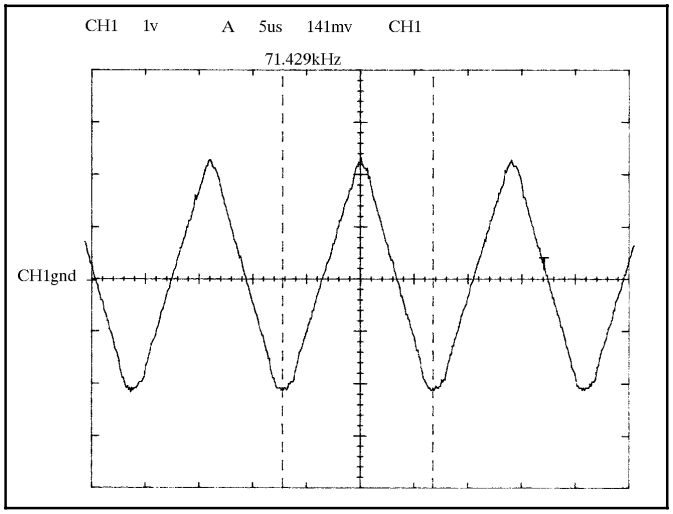


TP5

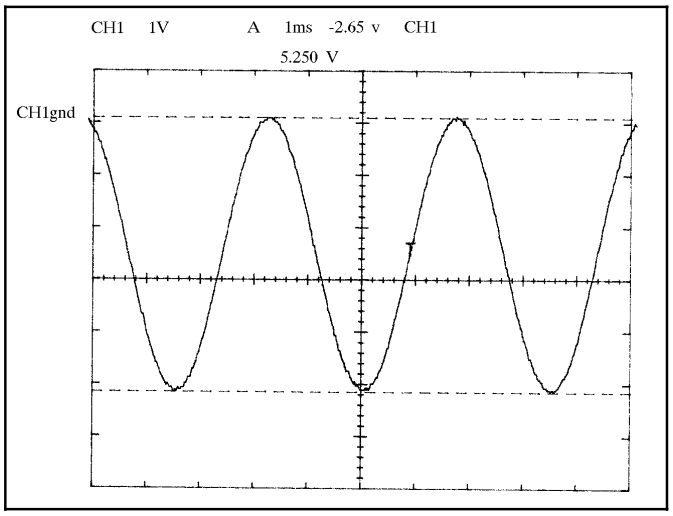
WARNING: Disconnect primary power prior to servicing.



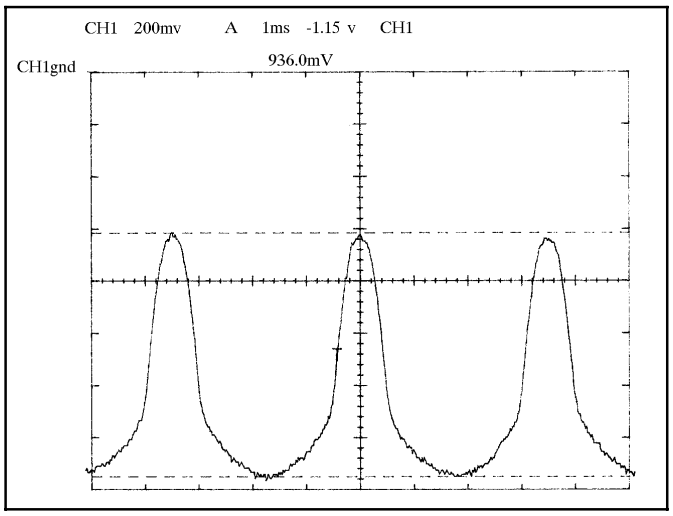
TP16



TP1

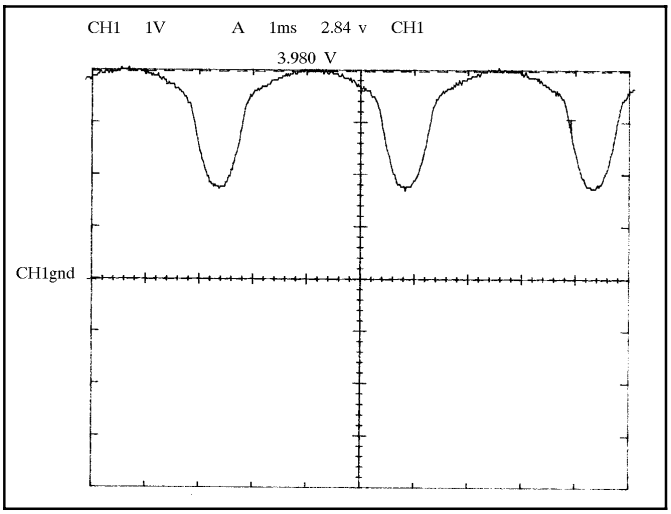


TP7

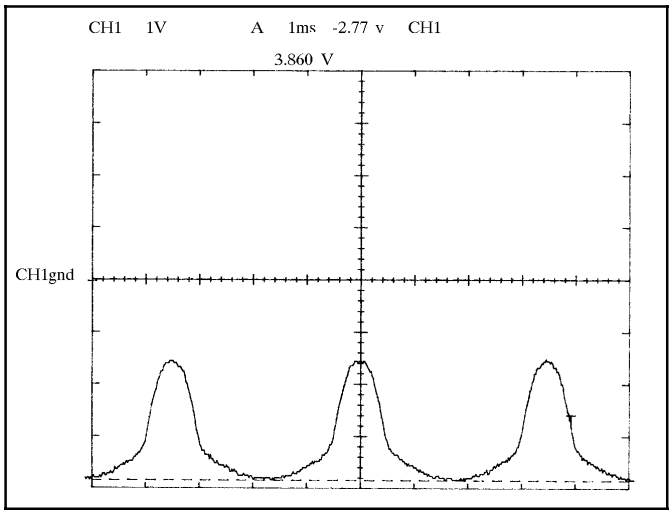


TP27

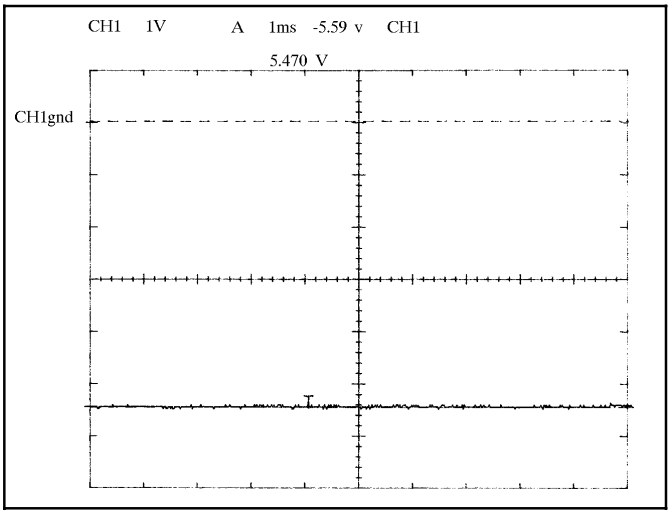
WARNING: Disconnect primary power prior to servicing.



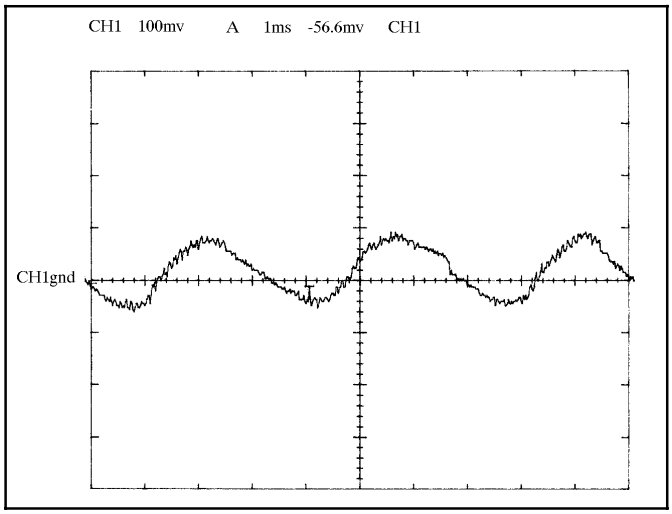
U10-7



U10-1

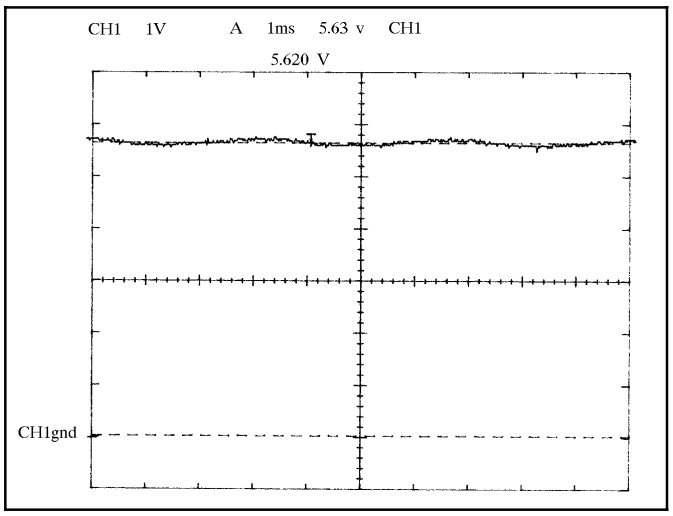


TP31

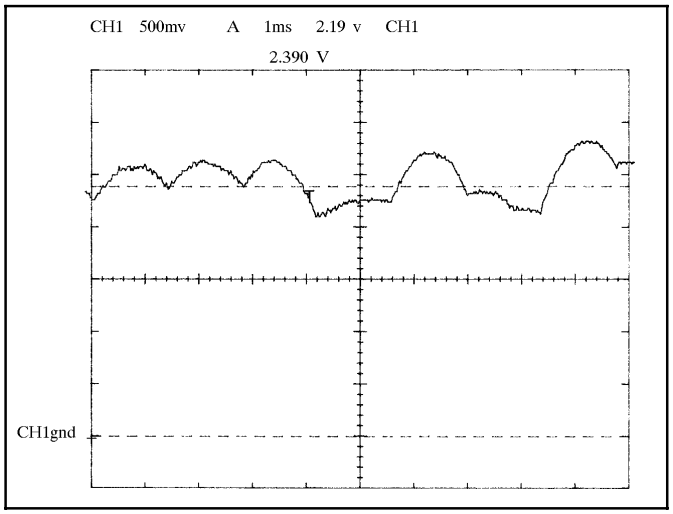


TP32

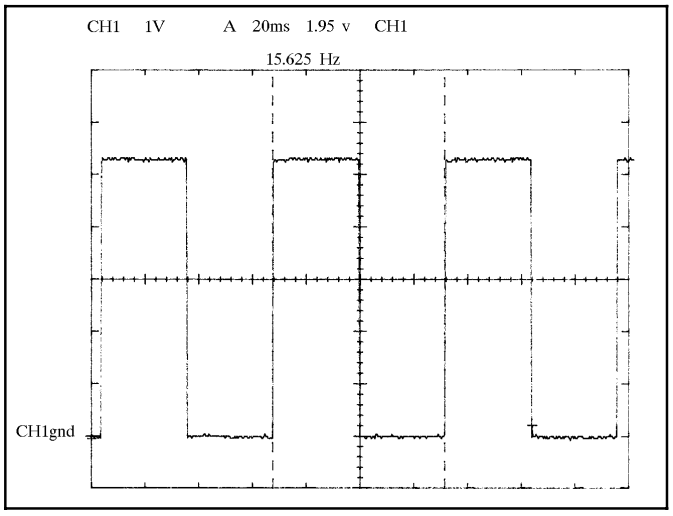
WARNING: Disconnect primary power prior to servicing.



TP2

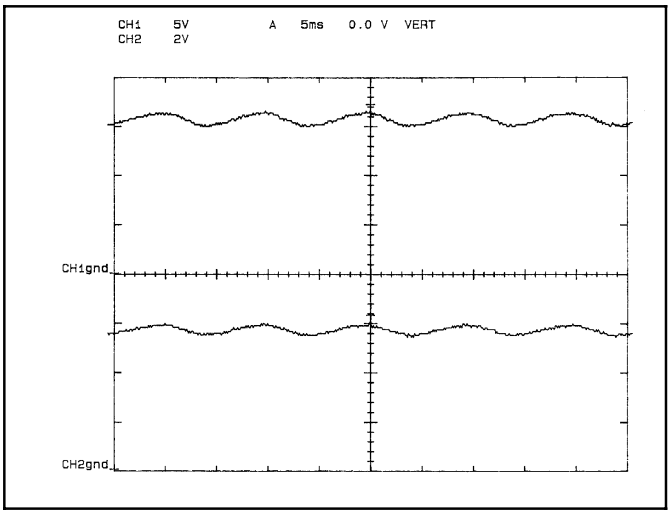


TP25

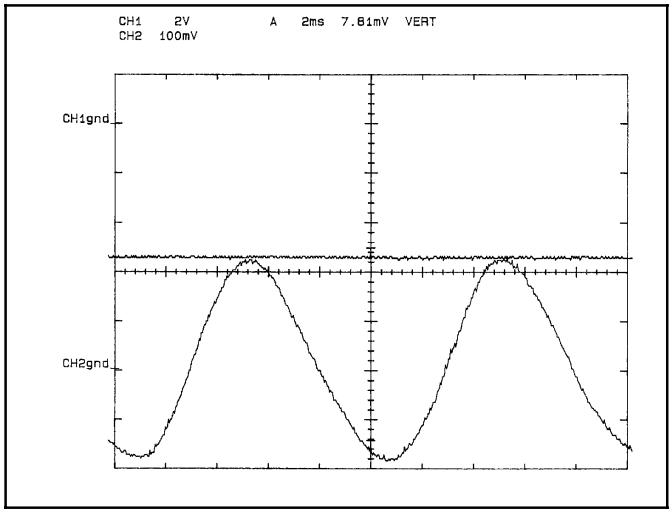


TP9

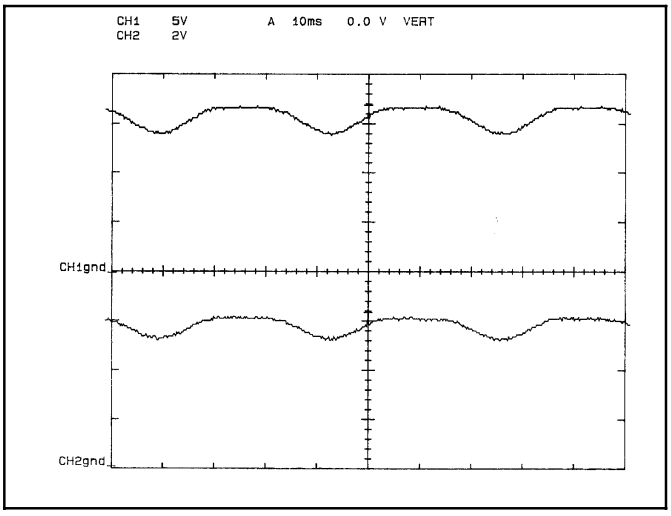
WARNING: Disconnect primary power prior to servicing.



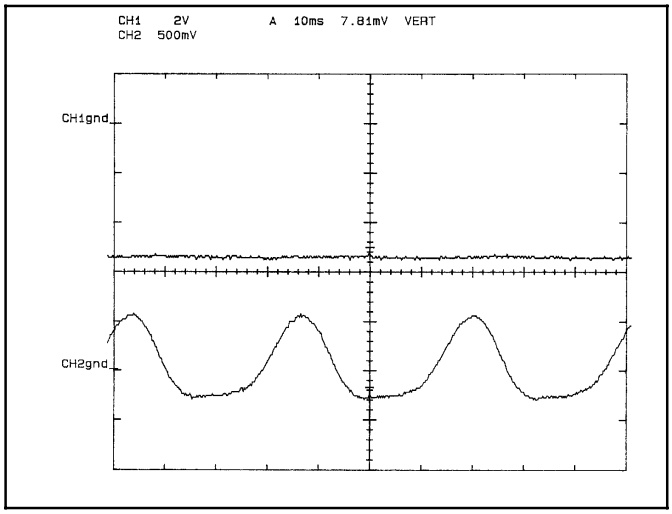
Upper Trace - CH1 - TP28
Lower Trace - CH2 - TP2
NOTE - 100Hz 95% Modulation 100kW



Upper Trace - CH1 - TP31
Lower Trace - CH2 - TP32
NOTE - 100Hz 95% Modulation 100kW



Upper Trace - CH1 - TP28
Lower Trace - CH2 - TP2
NOTE - 30Hz 95% Modulation 100kW



Upper Trace - CH1 - TP31
Lower Trace - CH2 - TP32
NOTE - 30Hz 95% Modulation 100kW

WARNING: Disconnect primary power prior to servicing.

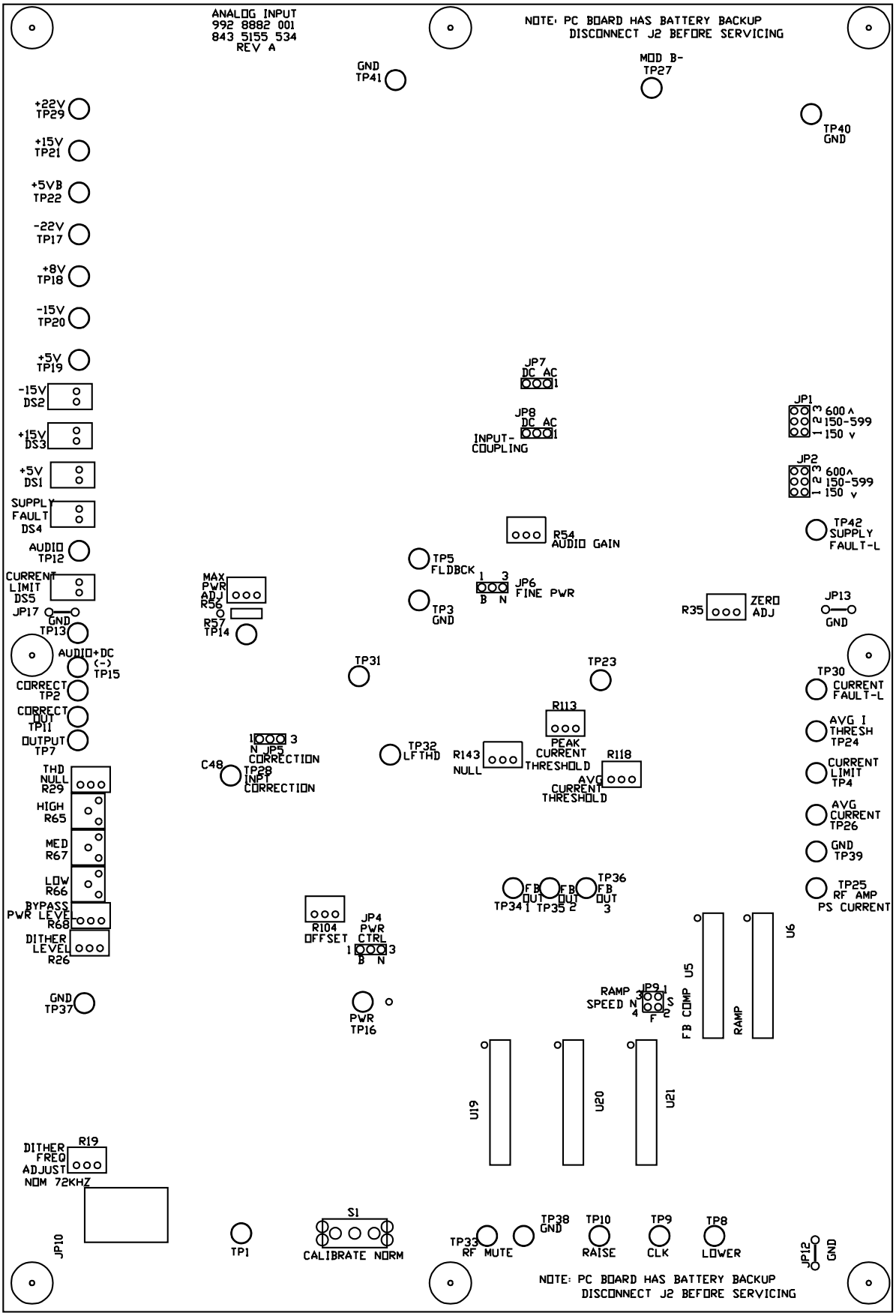


Figure J-2. Analog Input Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

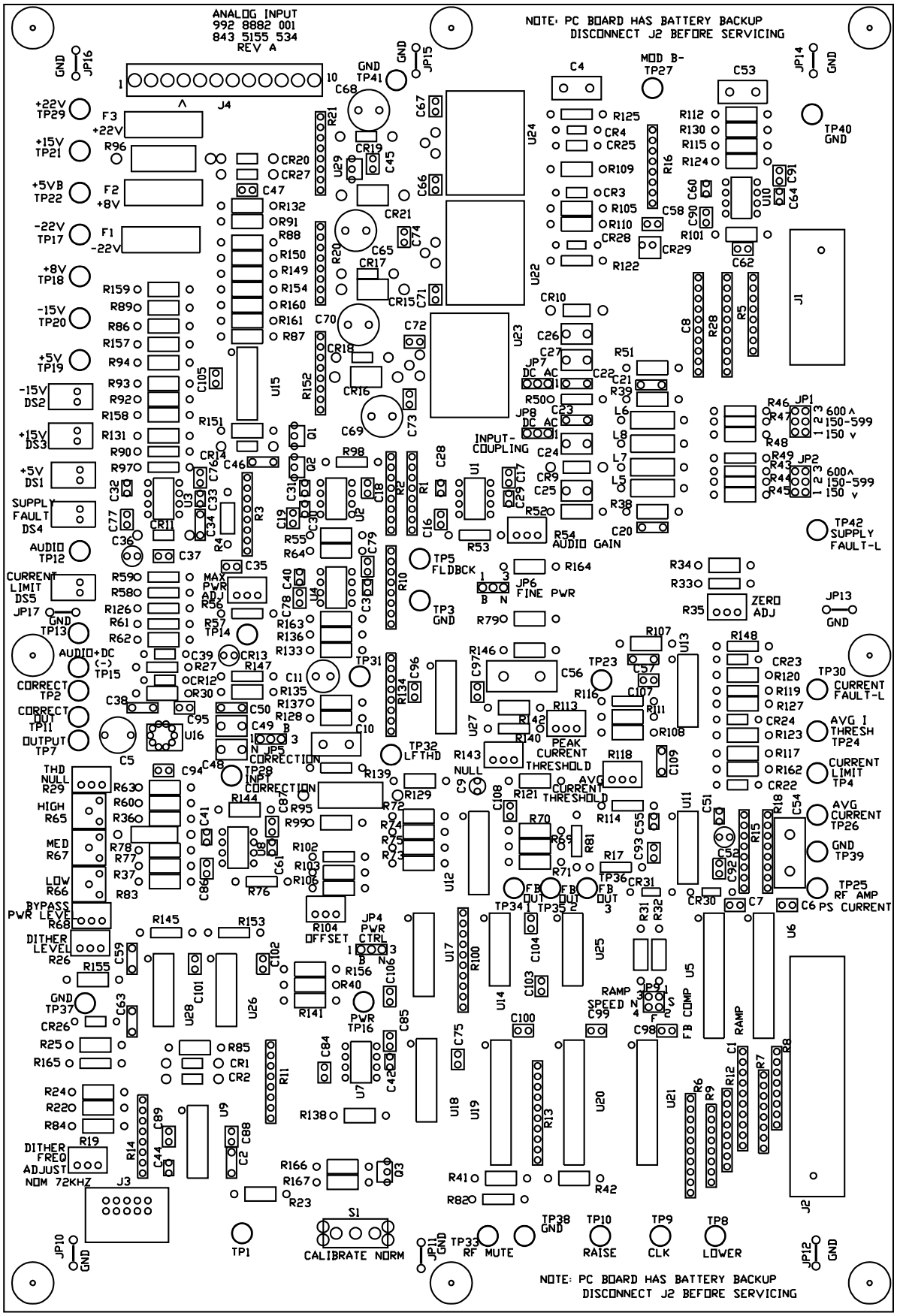


Figure J-3. Analog Input Component Locator

WARNING: Disconnect primary power prior to servicing.

Section K
Analog To Digital Converter

K.1 Introduction

This section describes the Analog to Digital Converter board, and includes Function, Location, Block Diagram Description, troubleshooting information and oscilloscope plots of key points.

NOTE: Parts List for this board is in Section VII.

K.2 Function

The Analog to Digital Converter board converts the (Audio + DC) signal from the Analog Input board into a Digital Audio Signal.

The Digital Audio Signal determines how many RF Amplifiers are to be turned on at any instant, via the Modulation Encoders.

Conversion functions, conversion fault logic, and data latches are included to accommodate these functions. Big Step Sync and Reconstructed Audio signals, for use in other sections of the transmitter, are also generated by circuits on this board.

K.3 Location

The Analog to Digital board is located in the center control compartment (SEE VIEW 13).

K.4 Block Diagram Description

K.4.1 RF Flow

An A/D Sample Pulse that is processed on the Driver Encoder is applied to a Buffer amplifier. The output frequency of the Buffer Amplifier is at the carrier frequency or 1/2 the carrier frequency depending upon the transmitter frequency. The output of the

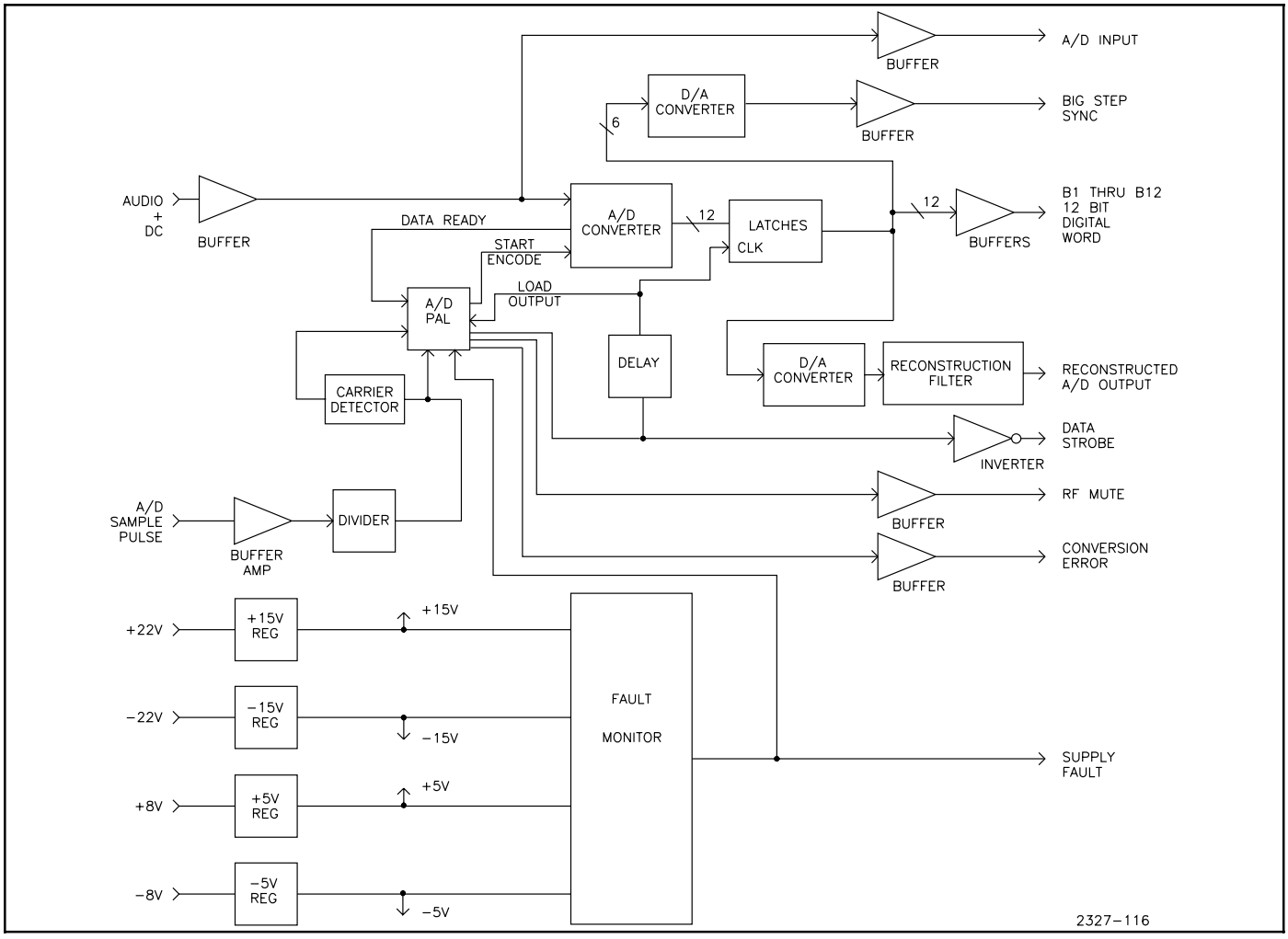


Figure K-1. Analog To Digital Converter Block Diagram

WARNING: Disconnect primary power prior to servicing.

buffer amplifier goes to a Carrier Detector and the A/D PAL. The Divider is not being used in this application. The Carrier Detector will send a fault signal to the A/D PAL should no RF signal be present.

K.4.2 (Audio + DC) Flow

The (Audio + DC) signal from the Analog Input is buffered by a Buffer amplifier and sent to the A/D Converter. The analog signal is sampled approximately once every two microseconds (the sampling rate depends on the transmitter frequency) and converted into a 12-bit digital audio signal by a high-speed analog to digital (A/D) converter. A Buffer amplifier is also driven by the (Audio + DC) and its output is called A/D Input. It is sent to the Control Multimeter for testing purposes.

K.4.3 A/D Converter

The A/D Converter and the A/D PAL operate in sync with each other. (Audio + DC) from the Buffer and a Start Encode signal from the A/D PAL allows the A/D Converter to convert the instantaneous (Audio + DC) analog signal to a 12 Bit digital word that digitally represents the analog signal. When the A/D Converter has finished the conversion process, it sends a Data Ready signal back to the A/D PAL and the 12 Bit digital word is present at the 12 outputs B1-B12 of the A/D Converter.

K.4.4 Latches And Buffers

The 12 Bit digital word is transferred into the Latches by the Load Output signal from the A/D PAL. Data Latches store the digital data after each conversion and hold the data until the next conversion is completed. These 12 data lines are sent to Buffers and applied to each Modulation Encoder.

K.4.5 A/D PAL

The A/D PAL accepts the A/D Sample Pulse from the Divider and provides the A/D Converter with Start Encode signals. When the conversion process is finished by the A/D Converter, a Data Ready pulse is sent back to the A/D PAL.

A Load Output from the A/D PAL is used to transfer in the 12 Bit digital word into the Latches.

A Data Strobe output from the A/D PAL is inverted by an Inverter and applied to each Modulation Encoder to latch in the current 12 Bit digital word.

The A/D PAL also monitors the timing sequence described above and can generate an RF MUTE, Conversion Error, or stop the Start Encode signals if a carrier loss or supply fault is detected.

K.4.6 D/A Outputs

A full 12 Bit digital word is applied to a D/A Converter which converts the digital word back into a analog signal. The output after passing through a Reconstruction Filter (Audio + DC) is present at the output of the filter. The reconstructed signal is Buffered and sent to the Control Multimeter position labeled A/D OUTPUT. This meter position is used for troubleshooting purposes.

A second D/A Converter accepts the 6 most significant Bits B1-B6 and converts this partial digital word into pulses. These Big Step Sync pulses are Buffered and sent to the Analog Input board to trigger the Dither Oscillator.

K.4.7 Power Supplies

The Voltages +22VDC, -22VDC, +8VDC and -8VDC are regulated to +15VDC , -15VDC, +5VDC and -5VDC respectively. The resulting regulated voltages are used to power circuits on this board.

A Supply Fault Sense circuit monitors these supplies and can generate a Supply Fault for the A/D PAL and the Controller.

K.5 Detailed Circuit Description

Refer to the schematic diagram for the A/D Converter (839-7930-009) for all descriptions in this section.

K.5.1 Analog Input

The A/D converter analog input signal, at J4-10, is the (Audio + DC) from the Analog Input board. The DC component determines the unmodulated transmitter power output by turning on the required number of Big Step RF Amplifiers via the Modulation Encoders. Typically 66 Big Steps RF Amplifiers are turned on at 100 kilowatts).

The analog signal level at the board's input is high so that inverting amplifier U28 has a gain of less than 1 to provide the proper signal level to the A/D Converter.

A very small amount of "Big Step sync" is added to the input signal at the inverting input of U1 (pin 2, via R5). When a Big Step RF Amplifier turns on, a small amount of the Big Step Sync component forces the input to the A/D higher. This is sufficient to ensure that the A/D Converter will not switch back to the previous step.

K.5.2 A/D Converter

A high-speed 12-bit analog to digital converter is used in the transmitter. The analog input voltage range is 0 to +5 Volts. An input of zero Volts gives a digital output of "0000 0000 0000." An input of +5 Volts gives an output of "1111 1111 1111".

The Analog to Digital converter has two signal inputs, an analog signal input at pin 22, and a TTL logic START CONVERT input at pin 18. The conversion is started by the Start Convert pulse.

K.5.2.1 A/D Converter Timing

The Start Encode pulse at TP2 (see plots and A/D Timing Sequence) goes high for 840nS and then returns low. The DATA READY pulse at TP3 that is normally high, goes low 528nS after the START ENCODE signal. The DATA READY remains low for 140nS. The DATA STROBE which is an inverted output of U5-15 at U10-2 is normally high. 564nS after the START ENCODE the line goes low for 140nS. The LOAD OUTPUT is normally low and it goes high for 140nS, about 624nS after the START ENCODE signal.

The twelve TTL level output lines are at pins 1 through 8 and 37 through 40. Pin 37 is the least significant binary bit (LSB), and

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pin 8 is the most significant bit (MSB). Pin 9 is a DATA READY TTL logic output.

K.5.3 Data Latches

The digital Data Latches store the digitized audio information while the A/D converter is performing the next conversion. When the next conversion is completed, the LOAD OUTPUT signal from the TIMFLT PAL clocks the data latches and stores the new digital audio information.

U6 stores the 6 most significant bits (MSB's), and U7 stores the 6 least significant bits (LSB's).

A logic LOW signal to the clear the latches at Pin 1, will cause all outputs to go LOW. All outputs will remain LOW as long as the CLEAR input remains low, no matter what the data or clock inputs are. The CLEAR input is normally High, and will only go low when a timing fault has occured. The Clock input to the Data Latches is the LOAD OUTPUT pulse. The positive-going edge of the pulse is the Clock input, which causes the output of each data latch to go to the same state as its input at that instant. The outputs will then remain in that state, storing the data, until another clock input, or until the latch's CLEAR input goes low.

K.5.4 Buffers

Buffers provide data outputs to drive the inputs on the modulation encoder board. Hex buffers U8 and U9 each contain eight sections, When a buffer input is high (logic 1), its output is also high, and when a buffer input is low (logic 0), its output is also low.

K.5.5 Frequency Dividers

The frequency divider's output at TP4, CLOCK, is the input frequency, because the jumper plug is installed in P10-2 to 1 in this application.

The frequency divider output goes to the TIMFLT PAL and to the carrier detector.

K.5.6 Data Strobe

The DATA STROBE signal Clocks the data latches on the Modulation Encoders, so that digital audio data is stored in the Modulation Encoders after the A/D conversion is complete.

The Data Strobe signal is derived from the LOAD OUTPUT signal from the TIMFLT PAL. When the conversion process is completed, the LOAD OUTPUT signal is delayed 60 nanoseconds by DL1, and becomes the Data Strobe signal at J1-35. Buffer U10-1 inverts the DATA STROBE signal and drives the circuits on the Modulation Encoder board.

K.5.7 Conversion Error Logic

Conversion Error logic on the TIMFLT PAL generates a DATA CLEAR logic signal which clears all digital data in latches U6 and U7 on the Modulation Encoder boards, and also generates a "Conversion Error" logic input, via the data strobe, to the Controller. The LOAD OUTPUT is measureable at TP3 and goes to the CLEAR inputs of latches U6 and U7.

K.5.8 Big Step Sync

The Big Step Sync circuit produces a pulse each time a Big Step RF Amplifier turns on. A Big Step occurs whenever one or more of the six most significant bits (MSB's) in the digital audio signal changes. The Big Step sync pulses synchronize the Dither oscillator on the Analog Input board, and a small amount of Big Step signal is also added to the analog input (Audio + DC) signal at the A/D Converter input.

K.5.9 D/A Converter

An 8-bit D/A converter is used to convert the six most significant bits of the digital audio signal back into an analog signal. The D/A converter output, at U15-4, is a zero to -1 Volt signal, made up only of Big Steps.

Switch S1 is provided for use in other transmitters. Both sections of S2 are open in the DX100-3F.

The output of the D/A converter is amplified by U16-U18. Low-pass filter R39-C49 removes any sample frequency and other high frequency components. A small stepped "big-step sync" signal which is added, through R70, to the Analog Input Signal. R41 and C81 form a differentiator, which produces a pulse each time a Big Step transition occurs. The pulses can be observed at the output of U19 at TP21, BIG STEP SYNC. The output signal from U19 goes to the Dither Oscillator circuit on the Analog Input board.

K.5.10 D/A Converter/Audio Reconstruction Filter

The 12-bit digital audio signal is converted back to an analog signal in by D/A converter circuit U11. The unfiltered D/A converter circuit's output is at U12-7, and is available for viewing at test point TP9. The unfiltered output at TP9 includes a DC component, and at full power with 100% modulation varies between zero and about +5 Volts. At lower power levels and/or lower modulation levels, the maximum signal amplitude at TP9 will be smaller.

The Reconstruction Filter is a low-pass filter which passes the audio components and removes the higher frequency components in the "steps," effectively smoothing the output. Two 620-Ohm resistors, R19 and R22, are the terminating resistances at the input and the output of the filter. Operational amplifier U12 drives the A/D output meter position on the Control Multimeter, and Reconstructed audio is present at TP19.

K.5.11 Power Supplies

Three regulated voltages are provided by on-board regulators. Each regulator circuit is fused and transient protected.

a. U20 is used as a -15 Volt regulator.
b. U21 provides a +15 olt output and U23 provides a +5 Volt output.

DC supply inputs to the A/D Converter are +22 Volts, -22 Volts, +8 Volts and -8 Volts.

Each of these is from the low voltage power supply. The inputs are fused with 2A fuses F1, F2, F3 and F4 and regulated to +15, -15, +5 and -5 Volts using regulators U21, U22, U23 and U24, respectively. Each regulator output has a green Status LED that lights when

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the regulator is operational. The output of the regulators are transient protected by tranzorbs CR17, CR19, CR16 AND CR18.

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +22 and +8 volt supplies go through diodes CR21 and CR22 to regulator U26. The supply will be active if either F1 or F3 opens. This +5VB is used as the reference to the inputs of comparator U25 thru series voltage divider networks. The output of U25-1,2 will go low if either the +15VDC or +5VDC supply is lost. The output of U25-13,14 will go low if either the -15VDC or - 5VDC supply is missing. The low output turns Q4 on and establishes +2.5VDC at the base of Q5. TP11, Supply Fault will go low illuminating DS6 RED when Q5 turns on. This Supply Fault-L signal is applied to the TIMFLT PAL U5 and gies to the controller via J1-1.

K.6 Troubleshooting

K.6.1 Power Supply

K.6.2 Power Supply

If an A/D Converter supply fault is displayed on the Control front panel, then with only the low voltage on, check the LED indicators DS1 (+15V), DS2 (-15V), DS3 (+5V), DS4 (-5V) on the Driver Encoder.

Each of these LED indicators should be on if the individual supplies are operating normally.

K.6.2.1 DS6 Illuminated

DS6 will light under 2 basic conditions,

a. If any of the Low voltage supplies or regulators fail, or

b. If one of the regulated outputs is less than 80% of normal. This means that DS1, DS2, DS3 or DS4 could be lit and a supply fault still be detected, turning on DS6. The input supply voltages and the regulated supply voltages will have to be checked closely to determine why DS6 is lit.

K.6.2.2 No -5V (DS4 out)

a. If DS4 is not illuminated, check fuse F4 and replace if necessary.

b. If F4 is not open, measure F4 for -8VDC.

c. If F4 does measure -8VDC, replace U24.

d. If TPF4 does not measure -8VDC refer to the overall transmitter wiring diagram and the Transmitter troubleshooting section to troubleshoot the Low Voltage Supply.

K.6.2.3 No +5V (DS3 out)

a. If DS3 is not illuminated, check fuse F3 and replace if necessary.

b. If F3 is not open, measure F3 for +8VDC.

c. If F3 does measure +8VDC, replace U23.

d. If F3 does not measure +8VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

K.6.2.4 No -15V (DS2 out)

a. If DS2 is not illuminated, check fuse F2 and replace if necessary.

b. If F2 is not open, measure F2 for -22VDC.

c. If F2 does measure -22VDC, replace U22.

d. If F2 does not measure -22VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

K.6.2.5 No +15V (DS1 out)

a. If DS1 is not illuminated, check fuse F1 and replace if necessary.

b. If F1 is not open, measure F1 for +22VDC.

c. If F1 does measure +22VDC, replace U21.

d. If F1 does not measure +22VDC then refer to the overall wiring diagram and the Transmitter troubleshooting section to troubleshoot a problem with the Low Voltage Supply.

K.6.2.6 All LED Indicators lit

If all the LED indicators are lit, it is possible the fault sensing circuitry has failed. Proceed as follows,

a. Check TP24 for +5VDC and replace U26 if necessary.

b. If TP24 is okay, measure the voltage on TP11.

c. If this is a logic high, the signal is correct and no fault exists on this board. Refer to the Controller section of the manual and to the transmitter overall wiring diagram to continue troubleshooting this fault.

d. If TP11 is low, and TP5, TP6, TP7 and TP8 all have the correct voltages, then troubleshoot U25 and associated circuitry and replace if necessary.

K.6.3 Big Step Sync

Begin troubleshooting this circuit by:

a. Turning on the transmitter and modulating it with a 400 Hz tone to 95%. Observe the waveform at U16-6. (see plot).

b. If this audio signal is not present check for a signal on U16-3.

c. If an audio signal is not present on U16-3, replace U15.

d. If a signal is present at U16-3 replace U16.

e. If U16-6 is correct check for an audio signal at U18- 6. (see plot).

f. If this signal is not present replace U18.

g. If present check TP21 for a series of pulses (see plot).

h. If these pulses are not present replace U19.

K.6.4 A/D Converter

Faults with the A/D converter IC would be characterized by no or full output or by a series of spikes or on the audio.

NOTE

To provide maximum protection to the transmitter during troubleshooting of A to D faults it is recommended to unplug J1 on

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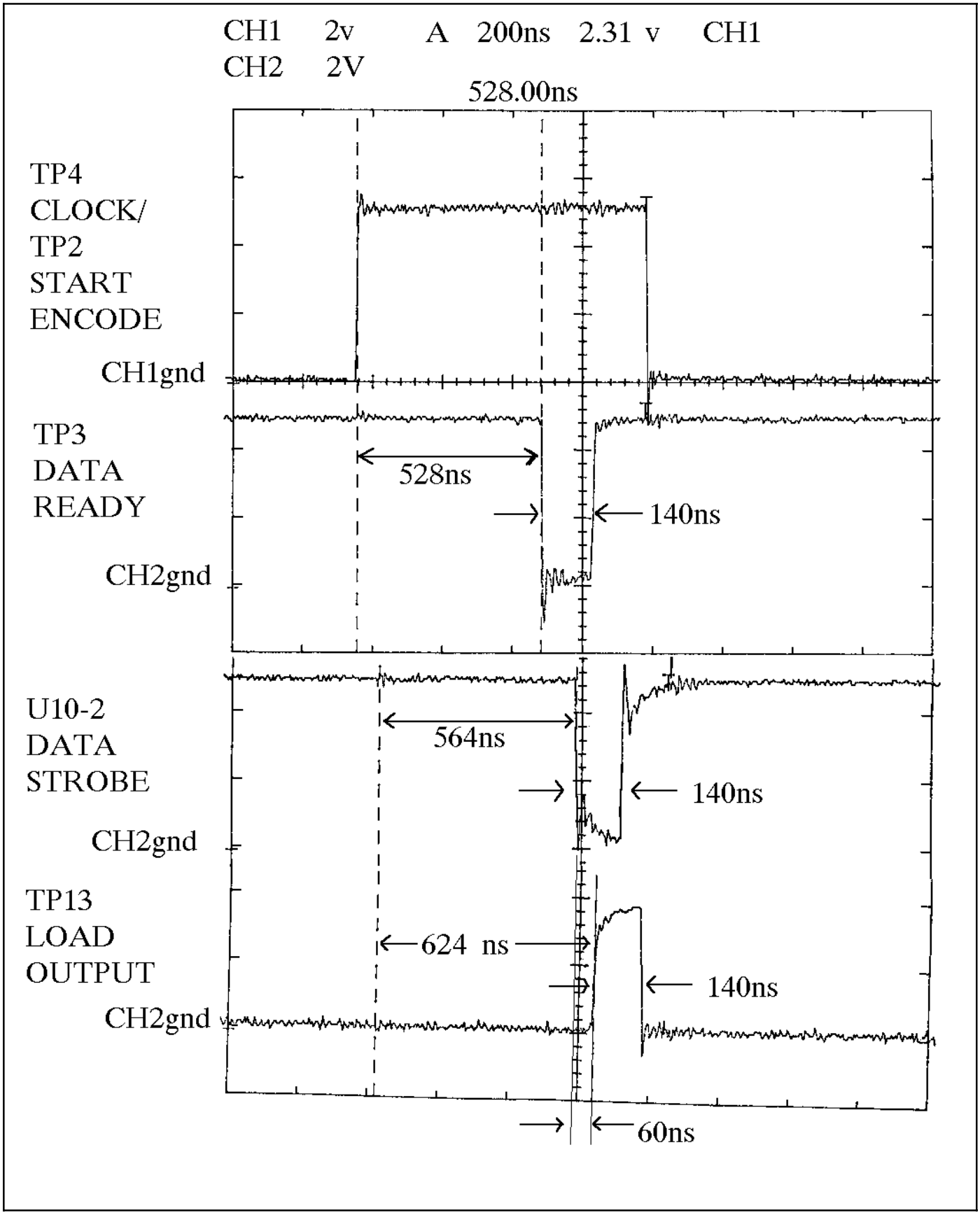

A/D Timing Sequence

WARNING: Disconnect primary power prior to servicing.

the A/D board. This will display an RF MUTE, A/D Supply Fault and Conversion Error on the Control front panel when the transmitter is turned on.

K.6.4.1 Transmitter goes to maximum power (All RF AMPS on)

a. Check the A/D input meter on the Transmitter Multimeter located in the Right PA compartment.
b. Compare this to the normal reading from the Factory test data or station log.
c. If this is not correct, check for the (Audio + DC) signal at TP22.
d. If this signal is correct check U1, CR1, CR2, and U14. If the A/D input is correct:
e. Apply an RF MUTE with S1 on the Controller. The meter reading should drop to zero.
f. Check the inputs to Latches U6 and U7. They should all be at logic low.
g. If any of these are high suspect a bad U3.
h. If these are all low check the output pins for a logic low.
i. If any of these are high, replace the Latch (U6 or U7) and or check U15.
j. If these outputs are low, check U8 and U9 for correct action.

K.6.4.2 No power output

Begin by observing if Conversion Error DS5 is illuminated on the A/D Board when the transmitter is turned on.

K.6.4.2.1 DS5 Illuminated

If the conversion fault is present, then while the transmitter is on:

a. Check TP4 for a clock pulse.
b. If this pulse is not present check for the pulses coming from the Driver Encoder at R12 of this board.
c. If the pulses are not present at R12, refer to the overall wiring diagram and the Driver Encoder Section to continue.
d. If the pulses are present check Q1, CR3, U10 and U4.
e. If the clock pulse is present on TP4, check for a series of Start Encode pulses at TP2 with the transmitter on.
f. If the start encode pulses are not present suspect a bad U5.
g. If the start encode pulses are present on TP2, apply audio to the transmitter and check the A/D input meter on the Transmitter Multimeter located in the Right PA compartment.
h. Compare this to normal reading from the Factory test data or station log.
i. If this is not correct, check for the audio +DC signal at TP22.
j. If this signal is correct check U1, CR1, CR2, and U14.
k. If the A/D input is correct, replace U5, and if fault remains replace U3.

K.7 Removal and Replacement

Remove the 10 screws and 4 connectors from the board. Reverse the procedure for replacement. When replacing the board set S1, P11 and P10 to the same setting as the removed board.

K.8 Alignments

There are no alignments needed on this board.

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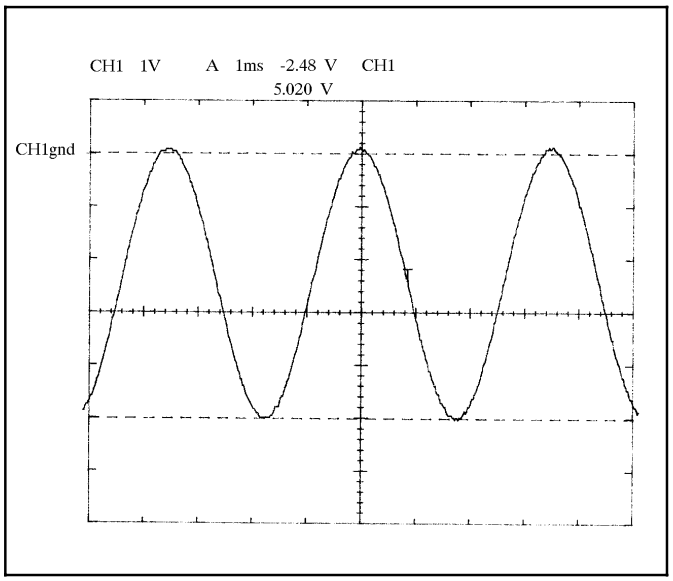
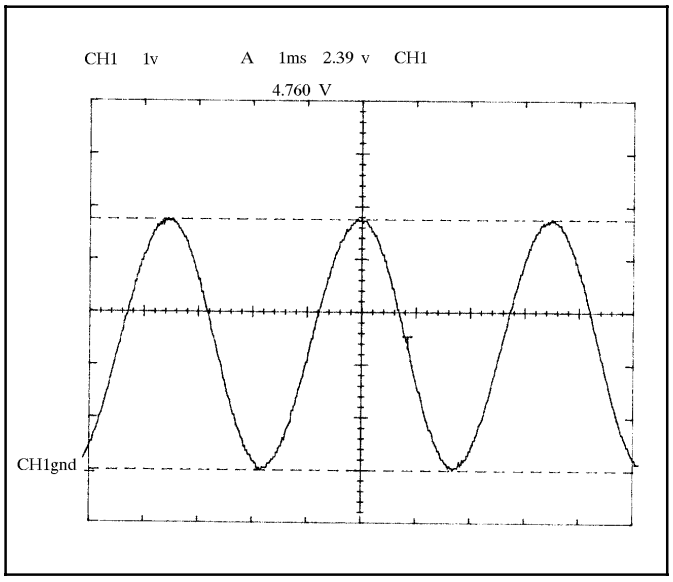
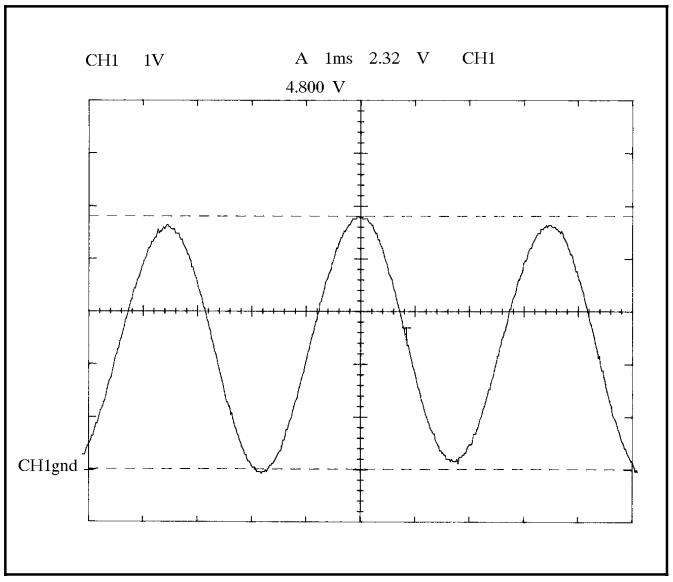


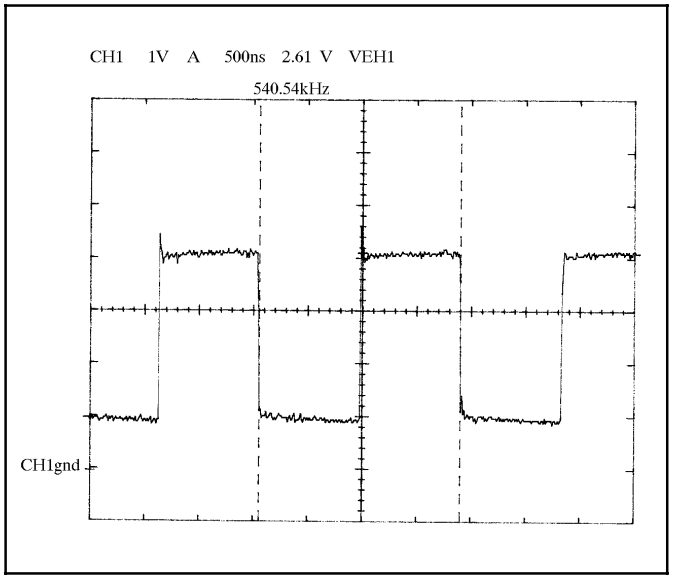
TP22



U3-22



TP1



J3-1

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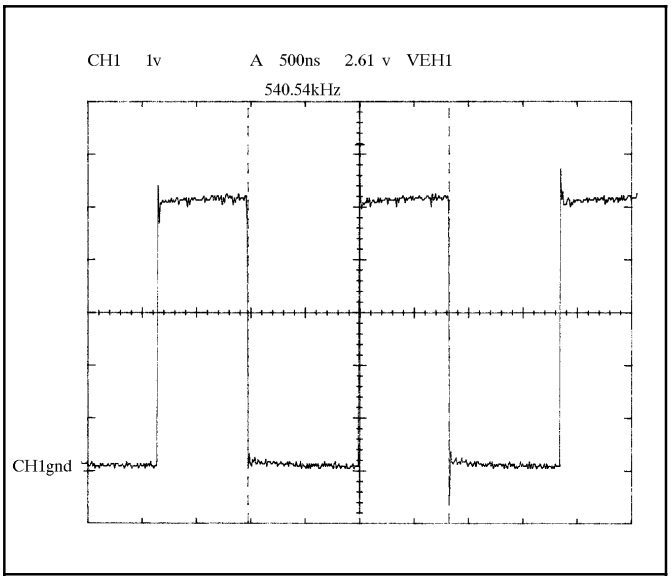
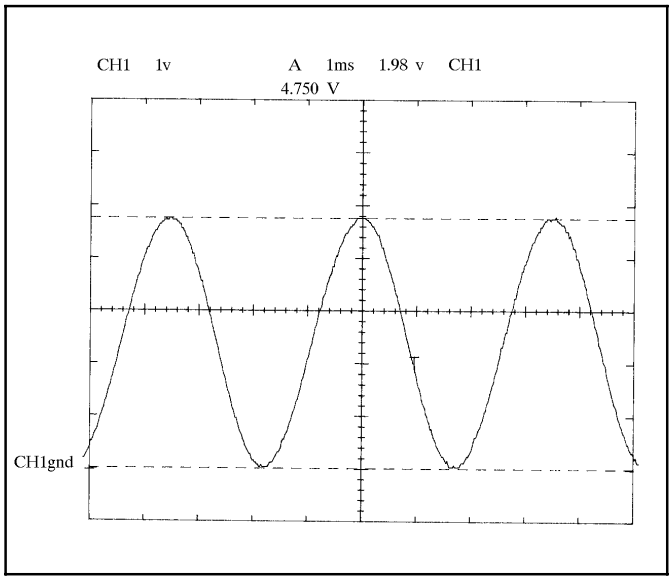
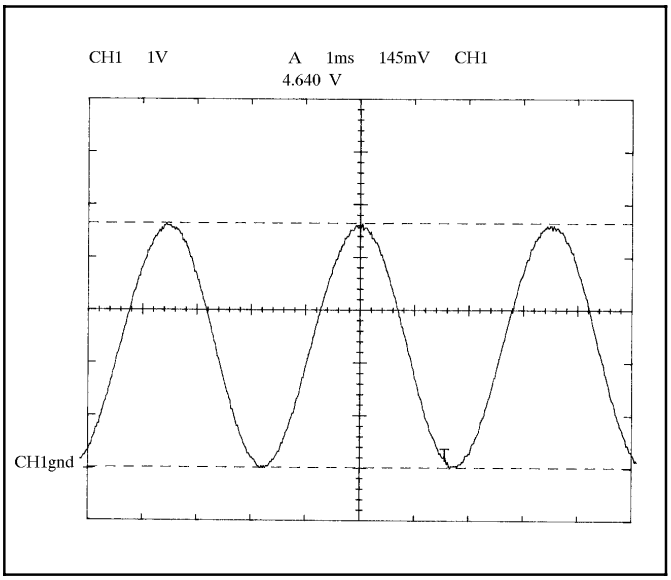


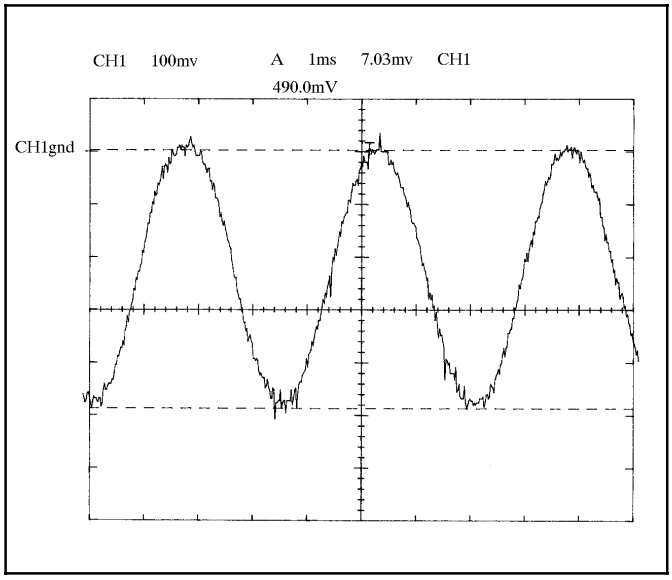
TP4



U12-7

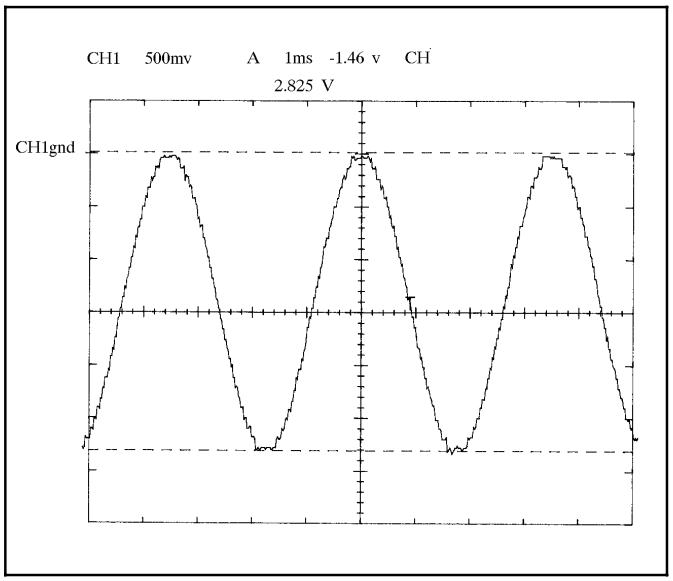


TP19

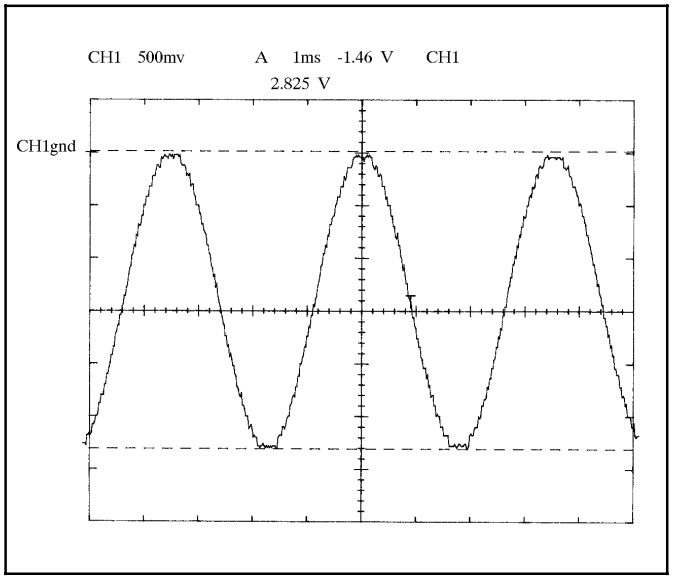


U15-4

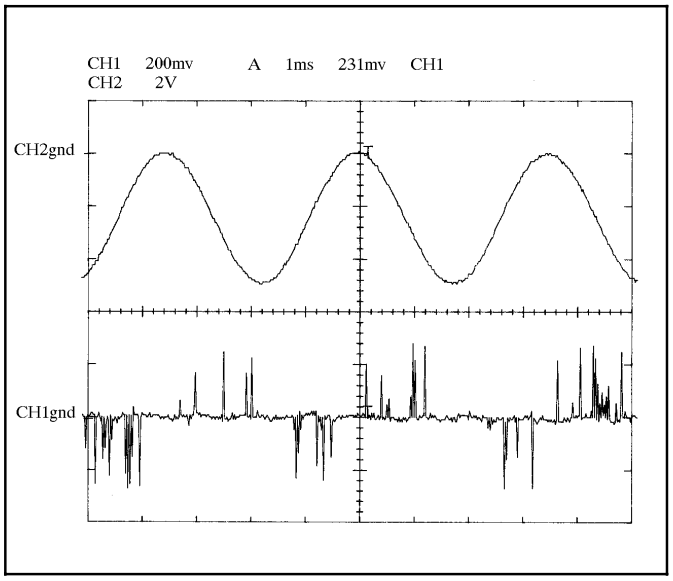
WARNING: Disconnect primary power prior to servicing.



U16-6



U18-6



Upper Trace - CH2 - TP22
Lower Trace - CH1 - TP21

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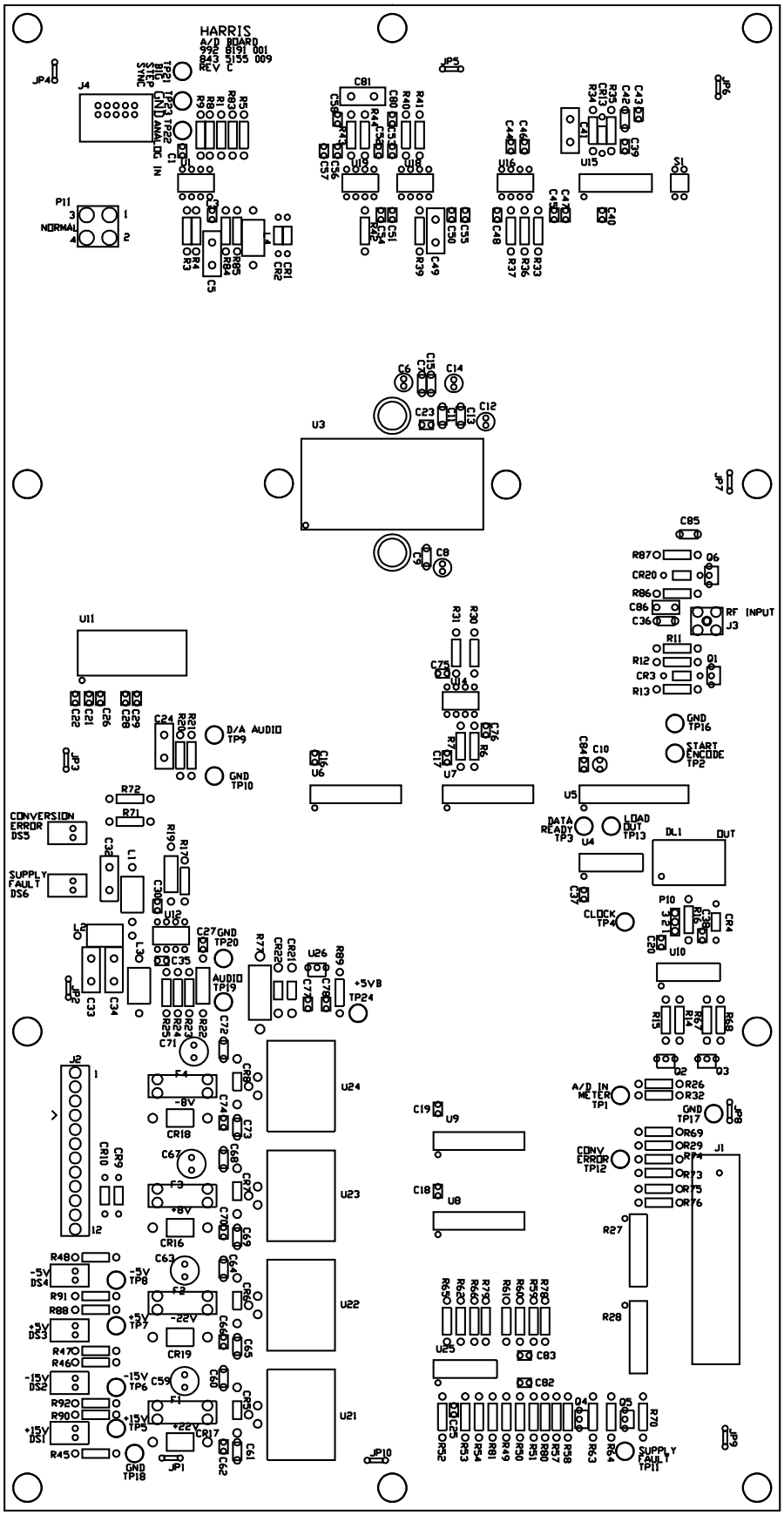

Figure K-2. Analog to Digital Converter Component Locator

WARNING: Disconnect primary power prior to servicing.

L.1 Introduction

This section describes the Big Step Modulation Encoder and the Binary Encoder boards. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, and Removal/Replacement.

NOTE: Parts List for this board is in Section VII.

L.2 Function

The Modulation Encoder board main function is to convert the 12 bit digital audio signal from the A/D converter into Turn ON/Turn OFF signals for the 156 Big Step and 4 Binary Step RF Amplifiers.

Each Modulation Encoder also has Module/Cable Interlock, Fuse Fault Detectors, and a Programmable Big Step RF Amplifier. Certain Encoders will monitor Air Flow and one detects RF Amp Temperature. If an RF Mute is applied, the Modulation Encoders will turn-off all RF Amplifiers and the power will drop to zero Watts, without turning off the RF Amp Power Supply.

The DX100-3F uses five Modulation Encoder boards (A25-A29).

A29 controls the Big Steps RF1-RF31/RF152 and monitors the temperature of RF1.

A28 controls the Big Steps RF32-RF62/RF153 and monitors the air flow in the left PA compartment.

A27 controls the Big Steps RF63-RF93/RF154.

A26 controls the Big Steps RF94-RF124/RF155 and monitors the air flow in the center PA compartment.

A25 controls the Big Steps RF125-RF151/RF156, Binary Amplifiers B9-B12 and monitors the Air Flow in the right PA compartment.

Big Steps RF152-RF156 are the Programmable RF Amplifiers.

L.3 Location

Mod Encoders A29 and A28 are located in the left PA compartment (SEE VIEW 14).

Mod Encoders A27 and A26 are located in the center PA compartment (SEE VIEW 12).

Mod Encoder A25 is located in the right PA compartment (SEE VIEW 10).

L.4 Big Step Modulation Encoders

L.4.1 Block Diagram Description

Refer to Figure L-1 Modulation Encoder block diagram for the following discussion.

L.4.1.1 Digital Audio Flow

For the following discussion, refer to Fig. L-1, Mod Encoder Simplified Diagram.

The Digital Audio Input from the A/D Converter is transferred into the Input Latches on each Modulation Encoder board.

The Data Strobe signal drives the clock input of the Input Latches and EPROM Encoder Latches. It transfers the data present at the inputs to the Latch outputs and holds the outputs at a constant level until the next Data Strobe signal from the A/D Converter occurs.

The eight Most Significant Bits of the Digital Audio Input B1 through B8 address EPROM Encoders. Each EPROM encodes the 8 bits and provides 8 outputs in a counting pattern determined by the Program Selector. One EPROM Encoder controls 8 RF Amplifiers, with 4 EPROMs per Modulation Encoder. The outputs of the EPROM are stored by Latches until the next Data Strobe.

The outputs of the Latches go to Encoder Output Drivers which are powered by the B+ and B- voltages. Their output provides proper turn-on/turn-off voltages for the RF Amplifiers assigned to that Modulation Encoder.

A Program Selector Switch and a Programmable RF Amplifier Control circuit will allow the user to substitute a designated programmable RF Amplifier in place of another RF Amplifier should it be required.

If an RF Mute is received or generated by the RF Mute Control, the Encoder Outputs will turn-off all RF Amplifiers.

L.4.1.2 B+/B- Regulators

When the TX On Enable input goes high from the Controller, the B+/B- Enable switch will turn on the B+ and B- Regulators and the Output Fault Sense detectors for both supplies. Should either supply be incorrect, a Supply Fault will be sent to the Controller and the transmitter will be shut OFF.

When the TX On Enable input goes low, the B+/B- Enable switch will shut down the B+/B- Regulators and disable the Output Fault Sense detectors.

+12VDC is applied to the B+ Unregulated Input, where it supplies the +5 Volt Regulators, Bypass Fusing and Regulation for the Bypass mode, and Fusing And Protection for the B+ Regulator.

The output of the B+ Regulator is a constant voltage that passes through Output Protection and is applied to the Normal Mode jumper. -12VDC is applied to Fusing And Protection and supplies the B- Regulator. +12VDC from the Fusing And Protection also supplies the B- Regulator.

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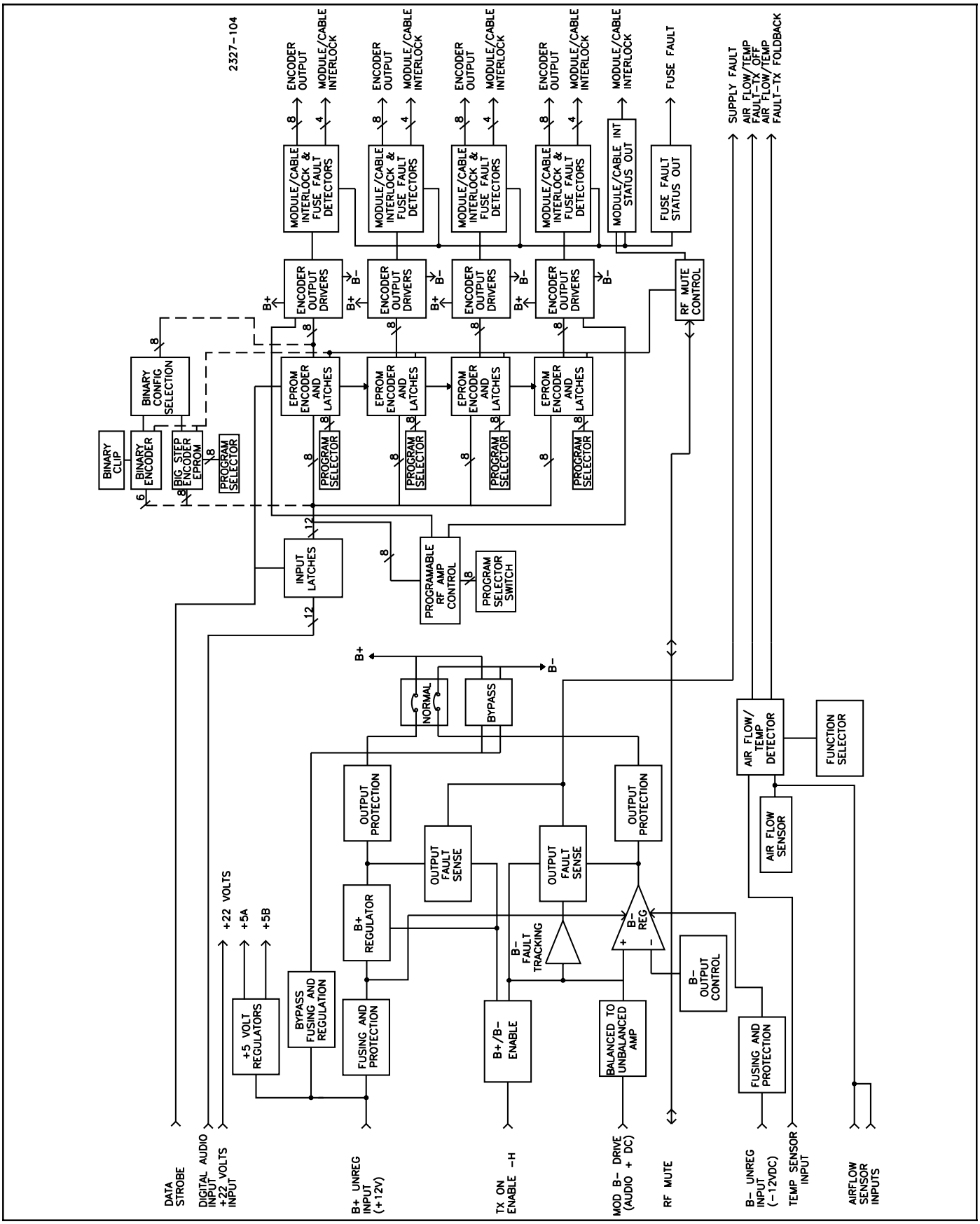

Figure L-1. Mod Encoder, Simplified Block Diagram

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Modulated B- Drive from the Analog Input board feeds a Balanced To Unbalanced Amplifier that drives the B- Regulator and the B- Fault Tracking circuit.

The output B- voltage from the B- Regulator varies with modulation and passes through Output Protection and is applied to the Normal Mode jumper.

Since the B- signal is constantly changing, the B- Fault Tracking circuit provides a reference for the Output Fault Sense.

L.4.1.3 Normal And Bypass Mode

When the Modulation Encoder is operated in the Normal mode, B+ and B- is distributed to all Encoder Output Drivers. If the jumper is moved to the Bypass mode, B+ is supplied to all Encoder Output Drivers and all RF Amplifiers are turned OFF.

L.4.1.4 Module/Cable Interlock And Fuse Fault Detectors

L.4.1.4.1 Module/Cable Interlock Detector

The Module/Cable Interlock Detector circuits on each Modulation Encoder board will generate a Module/Cable Interlock fault that will turn the transmitter OFF whenever an RF Amplifier is not inserted or an Encoder Output cable is disconnected. The Module/Cable interlock line from all 5 Mod Encoders, as well as from the Driver Encoder, are combined in a six input AND gate on the Transmitter Interface, and a single fault line is then sent to the Controller.

L.4.1.4.2 Fuse Fault Detector

The Fuse Fault Detector circuits on each Modulation Encoder board will indicate an RF or +230VDC fuse(s) has opened on an RF Amplifier. This will illuminate the RF AMP FUSE indicator RED on the Control front panel.

L.4.1.5 Air Flow/Temperature Sensing

The Function Selector on the A25, A26, and A28 Modulation Encoders is jumpered for Air Flow monitoring. An onboard Air Flow Sensor and up to 2 additional Air Flow Sensor Inputs are combined and sent to the Air Flow Detector.

If air flow is reduced up to a certain level, the Air Flow Detector will generate an Air Flow Fault-TX Foldback that will cause the Controller to foldback power output until a safe operating level is reached.

If a further reduction in air flow occurs, the Air Flow Detector will generate an Air Flow Fault-TX OFF, which will turn OFF the transmitter.

The Function Selector on the A29 Modulation Encoder is jumpered for temperature sensing. An external thermal monitor U1

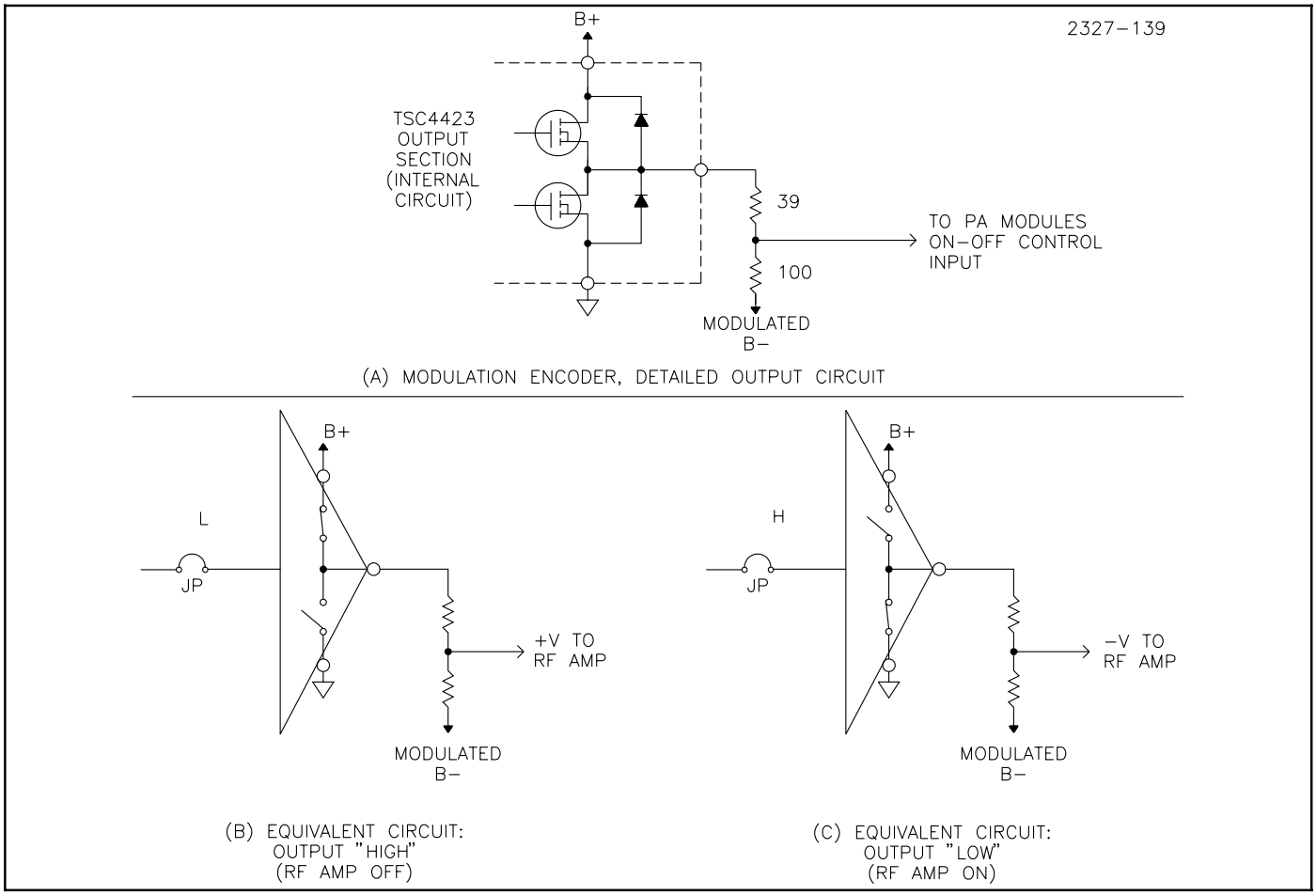

Figure L-2. Simplified Encoder Output Drivers

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mounted on RF1 is connected to the Temperature Sensor Input and fed to the Temperature Detector.

Similar to the Air Flow Detector, the Temperature Detector can generate a TX Foldback and TX OFF if the temperature reaches certain levels.

L.4.1.6 Power Supplies

The +5 Volt Regulators generate a +5A supply to power the digital audio circuits and a +5B supply to power control circuits on the board.

+22VDC is supplied to power the Module/Cable Interlock and Fuse Fault Detectors.

L.4.2 Detailed Circuit Description

Refer to the schematic diagram for the Modulation Encoder board (839-7930-011) for the following discussion.

L.4.2.1 Input Latch

The 12-bit digital audio input from the A/D Converter board is connected to J8 pins 1 through 23 (all odd numbered pins) on each Mod Encoder board.

Big Step Mod Encoders only use the eight most significant bits (B1 through B8) for control of the Big Step RF Amplifiers. They are connected to the input of Data Latch U16, which latches the data when a Data Strobe signal is present.

U17, U18, and U19 are not installed in the Big Step Mod Encoder boards.

The low-to-high transition at the leading edge of each Data Strobe pulse causes the outputs of U16 to change to the same logic state as it's input. All outputs will then remain in that state until the next Data Strobe pulse.

The output of U16 is distributed to the input of the five EPROM Encoders and to the Programmable RF AMP Selector.

L.4.2.2 EPROM Encoders

The eight bits (B1 through B8) from the Input Latch U16 are connected to the input of EPROMs U5, U6, U26 and U25 on pins 3 through 10.

Each EPROM contains the same program and has eight outputs, pins 11 through 19. A single spare EPROM can be used in any location on any Mod Encoder (Big Step or Binary).

Each EPROM encodes the incoming 8 bits by outputting a digital counting pattern that controls eight RF Amplifiers.

The Program Selector jumper plugs are installed into each Mod Encoder in JP1, JP2, JP4, and JP5. They determine which eight bit word the EPROM responds to and in which sequence.

The outputs of the EPROMs are connected to Output Latches U1, U21, U22 and U33.

L.4.2.3 Output Latches

The output of each EPROM U5, U6, U25, and U26 is connected to Output Latches U21, U1, U33, and U22 respectively.

The low-to-high transition at the leading edge of each Data Strobe pulse causes the outputs of the Latches to change to the same logic state as it's input. All outputs will then remain in that state until the next Data Strobe pulse.

The outputs of the latches go to Encoder Output Drivers, which provide turn-on/turn-off signals for Big Step RF Amplifiers.

A logic high on any output will turn on the associated RF Amp. A logic low turns the RF Amp off.

L.4.2.4 Encoder Positioning Jumpers

Refer to the Modulation Encoder Order Diagram (843-5155-162) and to VIEWS 10, 12 & 14 for the following discussion.

Mod Encoders on the left hand wall of the Left and Center Compartment are pointing upward (the heatsink is toward the bottom). P5 is jumpered 2-1 and P6 is jumpered 2-3 so that counting order sequence is from the second pin from the bottom of P4 straight up through to the top pin of P1A.

Mod Encoders on the right hand wall of the Left and Center Compartment are pointing downward (the heatsink is toward the top). P5 is jumpered 2-3 and P6 is jumpered 2-1 so that counting order sequence is from the second pin from the bottom of P1A straight up through to the top pin of P4.

Observing the rectangular blue jumpers with the gold plugs installed into P1A, P2, P3, and P4 is the fastest way to verify counting order and use the RF Amp Test function.

The blue jumper plug will always be installed in the P1A position for a Big Step Mod encoder, because it will always control 8 Big Step RF Amplifiers.

A logic high on any pin will turn on the associated RF Amp. A logic low or removal of the gold plug turns the RF Amp off.

L.4.2.5 Encoder Output Drivers

Up to this point the turn-on/turn-off logic signal for each RF Amp is a TTL level (0 to +5VDC).

The Encoder Output Drivers U7 through U14, U23, U24, and U27 through U32 convert this level to proper voltages for RF Amp turn-on/turn-off control. There is one driver for each RF Amp.

Pull-down resistors on each input holds the input low if the gold jumper plug is removed.

L.4.2.5.1 Inverters

Refer to Figure L-2, Simplified Encoder Output Drivers for the following discussion.

The output circuits of the TSC4426 drivers used have two internal MOSFETs, one to the IC's V+ terminal (B+) and one to the GND terminal (ground).

The drivers output goes to a voltage divider, made up of a resistor from the driver output and a second resistor to the Modulated B-Supply.

The junction of the resistors is the RF Amp turn-on/turn-off control circuit's input.

When the input is low, the upper MOSFET switch is closed and the inverter output is connected to B+. Due to the voltage divider action, the output to the RF Amp is approximately +2.5VDC and the RF Amp is turned OFF.

When the input is high, the lower MOSFET switch is closed and the inverter output is connected to ground. Due to the voltage divider action, the output to the RF Amp is approximately -1VDC

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(depending upon the Modulated B- Voltage) and the RF Amp is turned ON.

Connectors J1, J2, J3, and J4 carry the signal to the Big Step Combiner Motherboards where it is distributed to each RF Amp.

L.4.2.6 FLEXPatch™ - Programmable RF Amp Selector

A Programmable RF Amplifier is assigned to each Mod Encoder, therefore there are a total of five available in the transmitter.

This Programmable RF Amp is always at the bottom of the lowest Combiner Motherboard and therefore it's turn-on/turn-off control line is the very bottom gold jumper plug on the associated Mod Encoder.

Normally the Program Selector switches on each Mod Encoder designate the steps as RF Amps RF152 through RF156, the highest possible steps in the transmitter.

If an RF Amp should fail, one of these Programmable RF Amps can be substituted it its place. Only a slight reduction in positive peak modulation capability will result.

L.4.2.6.1 Digital Comparator

U4 is a Digital Comparator that controls the Programmable RF Amplifier.

Program Selector Switches S7 LSB and S8 MSB are used to provide an eight bit digital word to the Q comparator inputs Q0 through Q7.

The eight bit digital audio input (B1-B8) from U16 is applied to the P comparator inputs P0 through P7.

When the incoming eight bit digital word value from U16 is lower than the programmed eight bit digital word value, both U4-1 and U4-19 are high and the Programmable RF Amp is turned OFF.

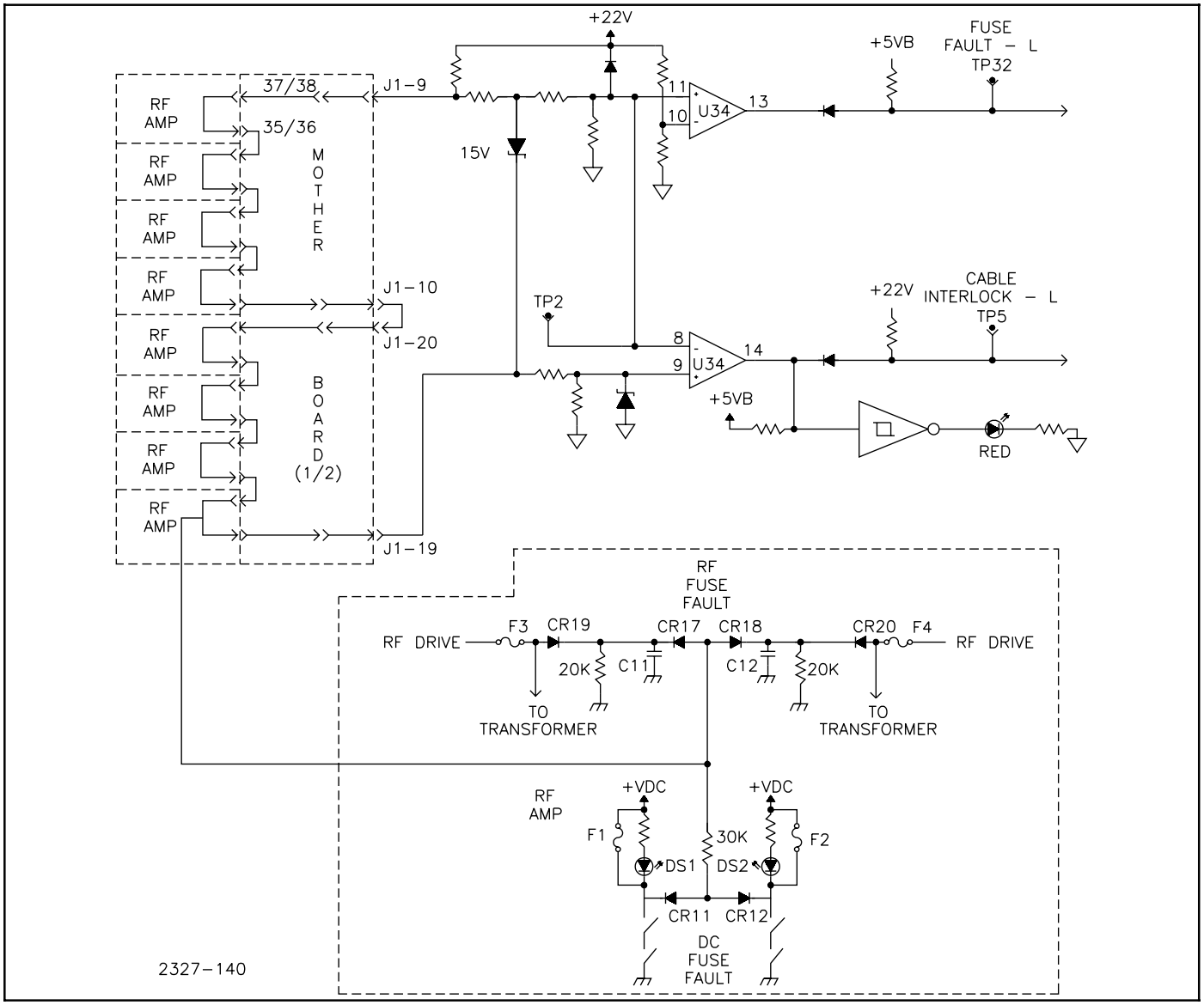

Figure L-3. Cable Interlock and Fuse Fault Detection Circuits

WARNING: Disconnect primary power prior to servicing.

When the incoming eight bit digital word from U16 matches the programmed eight bit digital word, U4-19 goes low.

The anode of CR2 is grounded and a voltage divider applies +3VDC to the base of Q1.

This saturates the transistor and the collector is pulled high. This high signal is applied to Encoder Positioning Jumpers P5 and P6, and will turn ON the Programmable RF Amp.

When the incoming eight bit digital word from U16 is greater than the programmed eight bit digital word, U4-19 goes high and U4-1 goes low. The Programmable RF Amp is still turned ON. For more information on setting the Programmable RF Amp see the Emergency Bypass procedures in Section 6A.

L.4.2.7 Data Strobe

A Data Strobe signal from the A/D Board enters at J8-25 and drives the Clock inputs of the Latches.

Each Latch is clocked by a low-to-high transition, so the Data Strobe-L pulse must be inverted.

Inverter U15-2 provides the low-to-high transition at the beginning of the Data Strobe-L pulse. This results in the eight bit digital word present at the inputs of the Latches being transferred to the outputs at the same constant level until the next Data Strobe signal occurs.

L.4.2.8 RF Mute

The RF Mute line is tied to the Clear input on all Latches.

When the RF mute line is low all latch outputs go low, turning OFF all Big Step RF Amplifiers. Inverter U15-6 goes high and DS1 RF Mute is illuminated YELLOW.

An RF Mute signal is generated when any of the following occur:

a. The transmitter is turned off and in the Test Mode.
b. A Manual RF Mute is activated on the Controller board.
c. A Remote Control RF Mute is activated via the External Interface board.
d. A Cable Interlock-L fault exists on any of the 5 Mod Encoder Boards.
e. The Output Monitor board detects excessive VSWR.
f. The A/D Converter detects a conversion error.

L.4.2.9 RF Amplifier Test

The RF Amp Test allows testing of the Encoder Output Drivers, connecting cables, and the RF Amp turn-on/turn-off control circuits by presenting a high on the input to the Encoder Output Drivers.

The circuit consists of a P10 1-4 which is connected to +5VA through limiting resistor R85.

L.4.2.10 Module/Cable Interlock

Refer to Figure L-3 Cable Interlock and Fuse Fault Detection Circuits for the following discussion.

The Cable Interlock circuit will turn the transmitter OFF if any of the interconnecting cables between the Modulation Encoder Boards and Combiner Motherboards are disconnected, or any RF Amplifiers are not installed. If any circuit generates a fault, the Encoder Cable Interlock LED will illuminate RED in addition to any on board indicator. A Cable Interlock Fault will not allow the transmitter to be turned ON until the fault is cleared.

There are 4 interlock circuits on each Mod Encoder, each interlock circuit monitors 8 RF Amplifier modules.

Since all interlock and associated control circuits are the same, only one interlock will be discussed.

The cable interlock function is provided by two series connections. When all the RF Amps and Mod Encoder cables are properly connected, a closed circuit is established from J1-9 to J1-10 (by four RF Amps and one cable) and from J1-20 to J1-19 (by four RF Amps and one cable).

Due to the voltage divider action of R89, R91, R53(7,8), R52(6,1), and R53(5,6) and R52(4,1), the voltage at the + input of comparator U34-9 will be greater than the voltage at the - input U34-8.

When the interlock connection between J2-20 and J2-9 is opened by removing the encoder cable or unplugging an RF Amplifier, the voltage at the + input will be lower than the voltage at the - input due to the additional voltage drop provided by CR22.

The output of U34-14 would go low and diode CR25 will conduct and establish approximately 0.6VDC at the input of U48-1.

Inverter U3-2 will go high and the Interlock 1 indicator DS5 will be illuminated RED.

Whenever U48-1 is pulled low by CR25, CR27, CR29, CR31, or CR4, Inverter U48-12 goes high and saturates transistor Q2. An RF MUTE-L is applied to turn ALL Big Step and Binary RF Amplifiers OFF.

Inverter U48-10 goes high and saturates the transistor inside U35- 8. J7-7 goes low and the Controller will shut the transmitter OFF.

L.4.2.10.1 Interconnection Cable Interlock

When J8 is connected, J8-31 receives +5VDC from the Transmitter Interface. If this cable is disconnected, inverters U48-2/U48-4 and diode CR4 will pull U48-1 Cable Interlock low.

Due to the diode gating, none of the Interlock indicators will be illuminated RED.

L.4.2.11 Fuse Fault Detectors

Refer to Figure L-3 Cable Interlock and Fuse Fault Detection Circuits for the following discussion.

The open fuse detector circuits will cause the RF Amp Fuse LED to illuminate RED when one or more of the 160 Big Step or Binary RF Amplifiers has an open Supply Voltage or RF Drive fuse.

Other than the visual indication, no other action is taken by the transmitter.

L.4.2.11.1 Supply Voltage Open Fuse Detection

There are 4 detector circuits on each Mod Encoder, each detector monitors 8 RF Amplifier modules. Since all detector and associated control circuits are the same, only one detector will be discussed.

WARNING: Disconnect primary power prior to servicing.

The cable interlock function is provided by two series connections. When all the RF Amps and Mod encoder cables are properly connected, a closed circuit is established from J1-9 to J1-10 (by four RF Amps and one cable) and from J1-20 to J1-19 (by four RF Amps and one cable).

Due to the voltage divider action of R89, R91, R53(7,8), R52(6,1), and R53(5,6) and R52(4,1), the voltage at the + input of comparator U34-11 will be greater than the voltage at the -input U34-10.

The voltage established at J1-9 and J1-19 is approximately 15VDC.

Normally, when the transmitter is ON the fuses short the +230VDC around the 56k resistors and LEDs.

This reverse biases diodes CR11 & CR12 which does not allow any current to flow from the +22 Volt Supply through the 30k resistor on the RF Amp.

Typically what causes a supply voltage fuse to open is one or more shorted MOSFETs on one side of an RF Amp.

For example, shorted MOSFETs on the "A" side of the RF Amp apply a ground to the cathodes of the diode CR11 and LED DS1.

The supply fuse will open and current flows through the 56K resistor from the supply voltage illuminating the indicator RED on the RF Amp with the open fuse.

Current also flows from the +22V Supply on the Mod Encoder Board through the 30K resistor and diode on the RF Amp.

Therefore the voltage level at U34-11 drops below that at U34-10 forcing the output at U34-13 to go low.

When the output of U34-11 goes low, diode CR25 will conduct and establish approximately 0.6VDC at U48-9, Fuse Fault-L.

Whenever U48-9 is pulled low by CR24, CR26, CR28 and CR30:

a. Inverter U48-8 goes high and saturates the transistor inside U35-14. A Fuse Fault-L at J9-29 is sent to the Controller.
b. Inverter U48-6 goes low illuminating the Fuse Fault indicator DS6 RED.

The Cable Interlock line U34-14 will not go low because when U34-11 voltage decreases the reference at U34-8 also decreases, and U34-14 will stay high.

L.4.2.11.2 RF Drive Open Fuse Detection

The RF Drive Fuse detection circuits operate on the same daisy chain as the supply fuses, and in basically the same manner.

Normally, with good fuses, the RF Drive is rectified by CR19, allowing C11 to charge up to approximately +20V.

This reverse biases CR17 and the detector chain is unaffected.

If F3 were to open, the voltage on C11 would discharge through the 20k Ohm resistor R19.

This causes CR17 to be forward biased, which pulls the voltage on the Interlock chain to ground through CR17 and R19.

This pulls U34-11 lower than U34-10, which causes U34-13 to go low, causing the same transmitter action as explained in the previous paragraphs.

L.4.2.11.3 Fuse Fault Enable

When the transmitter is ON, the B+/B- Enable switch U44 supplies +5VDC at pin 12. This voltage is connected to the anode of DS6 Fuse Fault via R96. The Fuse Fault indicator is enabled at this time.

When the transmitter is OFF, the +230VDC supply and the RF Drive to each RF Amplifier is also off.

However, the Fuse Fault indicator DS6 will not illuminate RED because the supply from the B+/B- Enable switch U44-12 will be 0VDC.

L.4.2.12 Air Flow Monitoring - Mod Encoders A26 and A28 Only

The Air Flow Sense circuitry on the A26 and A28 Mod Encoders consists of an Onboard Air Flow Monitor and an External Air Flow Monitor that are summed together.

Mod Encoder A26 uses Air Flow Monitor A48 and monitors the Center compartment.

Mod Encoder A28 uses Air Flow Monitor A49 and monitors the Left Compartment.

Loss of a blower or restriction of air flow due to dirty filters or a loose fan blade, will cause an Air Flow Reduced - TX Foldback.

The Controller will Foldback the power -6dB (1/4 the selected power).

Further losses will cause an Air Flow Fault - TX OFF.

L.4.2.12.1 Onboard Air Flow Monitor

The Onboard Air Flow Monitor consists of an ambient temperature sensor, a "heated" temperature sensor, and a differential amplifier.

The ambient temperature sensor U40 is mounted under the board.

Its output is connected to the differential amplifier - input U38-2.

The heated temperature sensor U41 is thermally connected to a 30 Ohm 20W resistor R115 by an angle bracket. Both are mounted underneath the board, in front of the heatsink that is cooled by the air channel in the compartment. Its output is connected to the differential amplifier + input U38-3.

The differential amplifier U38-1 will only amplify the difference between these two inputs.

Whenever the transmitter is ON, B+ voltage is supplied to heat the resistor.

The output voltage of the heated sensor will increase as the resistor heats up and then will eventually stabilize because air flow is passing over both components.

Normal air flow in the transmitter will cause the voltage at U38-1 to stabilize. If air flow in the transmitter is decreased, the output voltage will rise.

L.4.2.12.2 External Air Flow Monitor

Refer to the schematic diagram for the Air Flow Monitor (839-7930- 022) for the following discussion.

Operation of this monitor is exactly the same as the onboard monitor, except for the added cable interlock.

The 10 conductor ribbon cable from J1 on the Air Flow Monitor is connected to J9 pins 1 through 10. J9 is a 20 pin jack. This supplies the monitor with +5VDC at J9-3 and B+ voltage at J9-1.

The Air Flow In voltage from the monitor at J9-5 can be measured at TP29.

When the cable is connected, the monitor presents J9-2 Interlock with a ground. If the cable is disconnected, R205-1 is not connected to ground and the transmitter can not be turned ON due to an Air Flow Fault- TX OFF.

L.4.2.12.3 Summing Amplifier

The voltage from the Onboard Air Flow Monitor at U38-1 is summed together by resistors with the voltage from the External Air Flow Monitor at R208. This summed voltage is connected to U38-13.

Summing amplifier U38-14 has an adjustable gain control R213 Air Flow Calibrate that is used to set the air flow trip point.

The voltage at U38-14 is fed to the Sensor Select Jumper J7-5.

A wire jumper on the plug J7 will connect J7-5 to J7-8 so that the Air Flow Sense circuit is connected to the Sensor Select fault comparators.

L.4.2.13 Temperature Monitor - Mod Encoder A29 Only

The Temperature Sense circuitry on the A29 Mod Encoder consists of an External Temperature Sensor U1 that is mounted on the heatsink of Big Step RF Amplifier RF1.

Poor cooling, high ambient temperature, or RF Amp overdissipation due to mistuning or VSWR fault conditions will cause an Air Flow Reduced - TX Foldback. The Controller will Foldback the power in selected steps until a safe operating level is reached. Further increases in temperature will cause an Air Flow Fault - TX OFF.

The 3 conductor cable from U1 is connected to J6. This supplies the sensor with +5VDC at J6-1 and ground at J6-4.

The Temperature Sensor In voltage from the sensor can be measured at J6-2.

The voltage from the sensor is buffered by U38-7. As the temperature of the sensor starts to increase, the voltage at TP6 Temperature will also start to increase.

The voltage at U38-7 is fed to the Sensor Select Jumper J7-6. A wire jumper on the plug J7 will connect J7-6 to J7-8 so that the Temperature Sense circuit is connected to the Sensor Select fault comparators.

If the cable is disconnected at J6, U38-5 will be pulled low to +6VDC and the transmitter can not be turned ON.

NOTE - No indication of this condition will be visible.

L.4.2.14 Sensor Select Fault Comparators

Operation of the Sensor Select Fault Comparators is the same if it is connected to the Air Flow Sense or the Temperature Sense circuits.

The voltage at J7-8 is buffered and inverted by U38-8 and can be measured at TP33.

U37-1 and U37-14 form a two level fault comparator circuit. A resistive voltage divider establishes voltages at the - inputs of the comparators, +3.0VDC at U37-6 and +3.5VDC at U37-8.

The + inputs U37-7 and U37-9 are connected together.

If the voltage at U37-7 and U37-9 continues to increase, it will become greater than the reference and U37-1 will go high.

When the output goes high, it will saturate the transistor inside U35-1 and an Air Reduced/Temperature Fault-L TX Foldback at J8-39 is sent to the Controller.

Inverter U49-6 will illuminate DS7 Air/Temp Fault RED, as a visual indication of the warning.

If the voltage at U37-9 continues to rise, the U37-14 will go high and saturate the transistor inside U35-7.

An Air/Temp Fault-L TX OFF will be sent to the Controller via J8- 37.

L.4.2.15 B+ Voltage

The B+ Supply provides a nominal +7.2VDC to the Encoder Output Drivers. See Factory Test Data Sheets for actual voltage. This voltage is fixed and does not vary. It is used in conjunction with the Modulated B- voltage to control the RF Amp turn-on/turn-off time.

L.4.2.15.1 B+ Regulator

The input Unregulated B+ voltage at J5-7,8 can be measured at TP10 Unreg B+. This input is fused by F3, while diode CR49 and capacitors C62 and C64 bypass transients and high frequency noise on the unregulated input.

The B+ Regulator U42 is a variable voltage regulator in a TO-3 case. It is mounted to the heatsink underneath the board. Pin 1 is the unregulated input, pin 2 the reference voltage, and pin 3 is the regulated output.

The output voltage is determined by the reference voltage at pin 2 that is established by the voltage sample divider R124 and R125.

Diodes CR42 and CR43 protect the regulator against incoming transient voltages.

When the B+ Regulator is enabled, the output B+ voltage is a nominal +7.2VDC and can be measured at TP12 B+. Indicator DS8 will be illuminated GREEN.

When P13 is in the Normal position, J13 pins 2 and 1 connects B+ to Encoder Output Drivers U7 through U14, U23 & U24, and U27 through U32. Should the B+ voltage become too positive, zener diode CR55 will clamp the line at +10VDC.

WARNING: Disconnect primary power prior to servicing.

L.4.2.16 Modulated B- Voltage

The Modulated B- Supply provides a negative voltage to the Encoder Output Drivers, which varies with the transmitter's audio input and power level.

The effect of the modulated B- voltage is to control RF Amp turn-on/turn-off times. Turn-on/turn-off times depend on loading on each RF Amp, which in turn depends on the total number of RF Amps which are operating.

At low power levels (including negative modulation peaks), only a few Big Steps are ON, and each RF Amp is lightly loaded. As additional Big Steps turn ON, the loading changes considerably and the required turn-on/turn-off times also change.

At higher power levels (more RF Amps turned ON), the loading on each RF Amp does not change nearly as rapidly when additional RF Amps turn ON (or turn OFF).

The B- voltage must be more negative on positive peaks, but must change more slowly as the transmitter's instantaneous output becomes greater (and more RF Amps are turned ON). Therefore, the B- voltage must vary in a non-linear manner as the -(Audio + DC) sample changes.

L.4.2.16.1 Modulated B- Drive Differential Amplifier

The balanced Modulated B- Drive from the Analog Input board, is applied to J7-1(-) and J7-3(+).

Differential Amplifier U47-1 accepts the balanced signal and converts it to a single ended output at TP15.

The signal at TP15 is used to drive the B- Regulator and the B- Fault Tracking amplifier.

L.4.2.16.2 Modulated B- Regulator

The Modulated B- Regulator U45 uses both the Unregulated B+ and Unregulated B-supplies.

The input Unregulated B+ voltage (described in the B+ Regulator section) is connected to U45-2.

The input Unregulated B- voltage at J5-10,11 can be measured at TP22 Unreg B-. This input is fused by F4, diode CR50 and capacitors C60 and C61 bypass transients and high frequency noise on the unregulated input. The voltage is connected to U45-7.

The B- Regulator U45 is a high power operational amplifier in a TO-3 case. It is mounted to the heatsink underneath the board.

U45 is connected as a non-inverting amplifier with adjustable gain control R150.

When the B- Regulator is Enabled, the output B- voltage depends on the modulated B-drive from U47-1. It can be measured at TP11 B- and indicator DS11 will be illuminated GREEN.

Should the B+ voltage become too negative, zener diode CR56 will clamp the line at -10VDC.

When P13 is in the Normal position, J13 pins 4 and 3 connects B- to all Encoder Output Drivers U7 through U14, U23 & U24, and U27 through U32.

L.4.2.16.3 Approximate Modulated B- Supply Output Voltages

At an operating power of 100 kilowatts and with 1kHz 100% modulation, the instantaneous Modulated B- voltage should vary between roughly -3 and -7.5 Volts.

At negative 100% modulation peaks, the instantaneous voltage should be approximately -3 Volts, and at positive 100% peaks, the instantaneous voltage should be approximately -7.5 Volts.

This voltage range will be less at lower operating powers.

For an operating power of 10 kilowatts, instantaneous Modulated B- voltage should be on the order of -2.8 Volts at -100% peaks and - 6.5 Volts at +100% peaks.

L.4.2.17 B+/B- Enable

The B+/B- Enable circuitry will turn on the B+ and B- regulators when the transmitter is ON and shut them off when the transmitter is OFF.

The TX-ON Enable-H from the Controller enters at J8-35 and is connected to the base of Q3 through the normally closed contacts of Regulator Test switch S6.

L.4.2.17.1 Regulators Enabled

When the TX-ON Enable line is high, transistor Q3 is saturated and TP14 goes low causing the following actions:

a. Pins 9, 10, and 11 of U44 are pulled low and the 3 analog switches are in the positions as shown on the schematic.

Switch A provides +5VB for the Fuse Fault Enable.

a. Transistor Q4 is cutoff and the voltage reference for U42-2 is normal.

L.4.2.17.2 Regulators Disabled

When the TX-ON Enable line is low, transistor Q3 is cutoff and the Shutdown line goes high causing the following actions:

a. Pins 9, 10, and 11 of U44 are pulled high and the 3 analog switches are in the position opposite to the one shown on the schematic.
    1. Switch A does not provide +5VB for the Fuse Fault Enable.
    2. Switch B grounds the input to the B- regulator.
    3. Switch C pulls the + inputs of the B+/B- Fault Sense comparators high via CR44 and CR45, disabling the circuits.
b. Transistor Q4 is saturated and voltage reference for U42-2 is grounded.

L.4.2.17.3 Regulator Test

Regulator Test switch S6 is used for troubleshooting the B+/B- Regulators when the transmitter is turned OFF.

If the switch is depressed and held down, DS8 B+ and DS11 B- should illuminate GREEN, DS9 Supply Fault should not be illuminated RED.

NOTE: Do not hold down the switch for longer than 1 minute without air flow cooling the heatsink.

L.4.2.18 B+/B- Fault Sense

Should the B+ voltage become too low (less positive) or the Modulated B- voltage become too low (less negative), Fault

WARNING: Disconnect primary power prior to servicing.

Sense comparators will generate an Encoder Supply Fault-L that will turn the transmitter OFF.

L.4.2.18.1 B+ Comparator

U37-2 is the B+ fault comparator. A resistive voltage divider formed by R128 and R20-8 supplies one-half the B+ voltage to the + input U37-5. A similar voltage divider establishes the 2.8VDC threshold on the - input U27-4.

Should the B+ voltage become lower than the threshold, the output U37-2 will go low.

Inverter U49-2 will go high and saturate Q5, causing a Supply Fault-L to be sent to the Controller at J8-33. Inverter U49-4 will also go high and illuminate DS9 Supply Fault RED.

L.4.2.18.2 B- Comparator and B- Fault Tacking

U37-13 is the B- fault comparator. A resistive voltage divider formed by R131 and R20-5 supplies a sample of the B- voltage the - input U37-10.

The B- Fault Tracking amplifier U47-7 takes a sample of the modulated B- drive prior to the B- regulator. A similar voltage divider establishes a reference signal of the modulated B- drive on the + input U27-4.

Should the B- sample become greater than the reference signal, the output U37-13 will go low.

This produces the same response as a B+ fault.

L.4.2.19 Normal/Bypass Jumper

Refer to the Emergency Operating Procedures for more information on Mod encoder bypassing.

L.4.2.19.1 Normal Position

P13 is usually inserted into J13, the Normal position.

In this location, J13 1-2 connects regulated B+ to the B+ buss (for Encoder Output Drivers) and the B+ Fault Sense. J13 4-3 connects modulated B- to the B- buss (for Encoder Output Drivers) and the B- Fault Sense.

L.4.2.19.2 Bypass Position

When P13 is inserted into J12, the Mod Encoder is in the Bypass mode.

In this location, J12 1-2 and 3-4 connects an unregulated B+ voltage supplied by resistors R132, R133, R211, and fused by F2 to both the B+ buss and B- buss. This will turn OFF all RF Amps controlled by the Mod Encoder by supplying a positive voltage to the RF Amp turn-on/turn-off control line.

The B- Fault Comparator is bypassed because the + input of U37-11 is pulled high by CR47 and R146. When this positive unregulated B+ voltage is on the B- buss, indicator DS10 Bypass will be illuminated RED.

L.4.2.20 Power Supplies

L.4.2.20.1 +22VDC

The unregulated +22VDC supply is used for the Module/Cable Interlock and Fuse Fault functions. It enters the board at J5-1 and is fused by F1. Indicator DS12 +22 will be illuminated GREEN when the supply is present and this voltage can be measured at TP9.

L.4.2.20.2 +5VDC Regulators

The Mod Encoder uses two +5VDC supplies, +5VA and +5VB.

The +5VA supply is used to power all the digital audio circuits.

The +5VB supply is used to power the fault and control circuits.

Both supplies are identical circuits and only the +5VA regulator will be discussed.

The Unregulated B+ input from J5-7, 8 is fused by F5 and connected to In terminal of U46-1. Bypass capacitors are used on the input and output terminals along with a protection diode CR58.

The output +5VDC at U46-3 can be measured at TP8 and DS13 will be illuminated GREEN when the supply is present.

L.4.2.20.3 -5VDC Regulator

U39 is a -5VDC regulator that is connected to a -12VDC supply formed by dropping resistor R171. The output -5VDC is used by the B+/B- Enable switch U44-7.

L.4.3 Troubleshooting Big Step Modulation Encoders

This board can be temporarily bypassed in an emergency. Refer to Section 6A for Emergency Bypass Procedure.

Since all five modulation encoders contain the same circuitry, use this procedure on any of the Mod Encoders A25-A29.

Faults with an encoder board can be classed into

a. Interlock/Fuse Fault
b. Air Flow Sensing
c. Supply Regulators, and
d. RF AMP turn on encoding.

Refer to the proper section for the area being addressed.

L.4.3.1 Interlock/Fuse Fault

If the Control Front Panel Displays a Module/Cable Interlock Fault upon Step Start, and the Transmitter troubleshooting section has referred to this section, begin troubleshooting by observing which Indicator DS1, DS2 through DS5, and DS6, is illuminated on the Mod Encoders. This can be done with only the Low Voltage on.

L.4.3.2 Cable Interlock DS2, DS3, DS4, or DS5 illuminated

NOTE

The circuitry for each indicator is identical therefore only one example will be given. Use the example for DS2 listed and refer to the schematic for the appropriate component locators for troubleshooting DS3, DS4 and DS5 indicator illuminated.

If DS2 is illuminated RED on the Modulation Encoder, one of the RF amplifiers or the encoder cable is not connected or open, or the Interlock circuitry has failed.

WARNING: Disconnect primary power prior to servicing.

WARNING

ENSURE THAT THE TRANSMITTER IS TURNED OFF AND ALL PRIMARY POWER IS TURNED OFF AT THE WALL DISCONNECT SWITCH BEFORE OPENING ANY DOOR OR PANEL. BEFORE REMOVING PANELS OR OPENING DOORS, VERIFY THAT THE RF AMP POWER SUPPLY IS DISCHARGED BY CHECKING "PA+VDC" ON THE FRONT PANEL MULTIMETER. USE A VOLTMETER TO VERIFY THE POWER SUPPLIES HAVE BEEN DISCHARGED PRIOR TO TOUCHING ANY COMPONENTS.

a. Start by ensuring that the RF modules are firmly inserted in the Combiner Motherboard.
b. If the fault remains follow the steps below.
   1. Using a clip lead, jumper the cathode of CR30 to R120 (J4-19 to J4-9).
   2. If DS2 goes out, refer to the Overall wiring diagram and the Combiner Motherboard section to trace an open cable.
   3. If DS2 is still illuminated, check the voltage on U36-2 for a logic low.
   4. If U36-2 is a logic low, check the voltage on TP18 and compare this to the voltage on U36-5.
   5. If TP18 is higher than U36-5, check CR35, R49, R120, C90 and CR32.
   6. If TP18 is lower than U36-5, replace U36.
   7. If U36-2 is a logic high, replace U3.
   8. If no indicator (DS2-DS5) is illuminated then check the cathode of CR34 for a logic low.
   9. If CR34 is a logic high refer to the Transmitter Interface and Controller Sections to continue.
   10. If CR34 is a logic low check U35-9 for a logic high.
   11. If U35-9 is high replace U48.
   12. If U35-9 is low, suspect U35 or CR35.

L.4.3.3 Fuse Fault

L.4.3.3.1 DS6 illuminated

a. If DS6 is illuminated and no RF AMPS indicate blown fuses (DS1 or DS2) check TP32 for a logic low.
b. If TP32 is a logic high, suspect U48,C110, and U35.
c. If TP32 is a logic low determine which stage is producing the fault by checking for a logic low on the cathodes of CR24, CR26, CR28 and CR30.

NOTE

Since the circuitry is the same for all fuse faults only one (CR24 low) will be used as an example. Refer to the Mod Encoder schematics to find the correct component for the actual stage producing the fault.

1. If the cathode of CR24 is low, compare the voltages on U34 pins 10 and 11.
2. If U34-11 is lower than pin 10, suspect R53 or CR22.
3. If these components are okay it may be possible that the modules being protected by that circuit are not being turned on or a fuse on one of the fuse boards is blown.
4. Refer to the transmitter Troubleshooting section on Control front panel indicators and the Overall wiring Diagram to Continue.
5. If U34-11 is higher than pin 10 replace U34.

L.4.3.3.2 None are Illuminated

If none of the LEDs are illuminated on any of the Mod Encoders check the cathodes of CR33 and CR34 for a logic low. The diode with the logic low is on the board generating the fault. Check U35, CR35 and CR34 on that Encoder board.

L.4.3.3.3 Air Flow and Temperature Sensing

There are three types of sensing circuits on this board that are summed together to generate air flow or temperature faults.

a. The Air Flow sensor in the cabinet
b. The on Board air Flow sensing for the B+ heatsink, and
c. The temperature sensor mounted on RF1.

If the Control front panel display shows an Air Flow Reduced, Air Flow fault, Temp and/or a Foldback fault and the Transmitter troubleshooting section has referred to the Modulation Encoder, begin troubleshooting by observing if DS7 is illuminated on the Mod Encoder board.

NOTE

The Fault must be active at the time of troubleshooting. This can be determined by the fact that Fault Reset on the Control front panel does not clear the fault.

If DS7 is illuminated:

a. Check TP7 and TP6 for a voltage greater than 3VDC.
b. If TP7 is greater than 3V then the temperature sensing circuit for RFA1 is faulty.
c. If TP6 is greater than 2.5VDC then an air flow sensing circuit has failed.

L.4.3.3.4 RF1 Temperature Sensing

a. If TP6 measures greater than 3VDC, the ambient air temperature is less than 50 Degrees C., and air flow to the modules is not restricted, then:
b. Check the circuitry by removing power and carefully bending U6-6 out of the socket.
c. Turn on the transmitter.
d. If the fault remains, replace U6.
e. If the fault clears replace the temperature sensor on the RF Amp Module.

L.4.3.3.5 Air Flow Sensor

If TP7 is greater than 3 VDC, the ambient air temperature is less than 50 degrees C, and air flow is not restricted to the compartment or over the Modulation Encoder board heatsink,then:

a. Check U38-2 for approximately +5VDC.
b. If not present suspect an open cable from the external air flow sensor.
c. If the voltage is present on U38-2, check U38 pins 2 and 3.
d. If pin 2 is greater than pin 3 replace U38 or U41, or check external air flow sensor, if used.
e. If pin 2 is less than pin 3 suspect a faulty U44.

L.4.3.3.6 Supply Regulators

If the Encoder section of the Control front panel displays a supply fault begin troubleshooting by:

a. Observing if the indicators DS12, DS13 and DS14 are illuminated on each Mod Encoder board with CB3 on the Power Supply Display panel in the STANDBY position.
b. If all these indicators are illuminated, turn on the transmitter and monitor DS9 on each board for a flash that would indicate the board generating the supply fault.
c. If DS9 does not illuminate on any board suspect a Controller or cabling problem.
d. If DS9 flashes on all boards suspect a fault with the Unregulated supply. Refer to the transmitter troubleshooting section to troubleshoot the low voltage supply.

L.4.3.3.7 DS12 not illuminated

This indicates that the unregulated +22 Volts is not present on the board. Check F1 and if not open, troubleshoot the Low Voltage Supply.

L.4.3.3.8 DS13 not illuminated

This indicates that the +5VA supply has failed.

a. Check F5 for approximately +12VDC. If not present refer to the transmitter troubleshooting section to troubleshoot the Low Voltage supply.
b. If F5 checks okay, suspect C73, C72 or U46.
c. If U46 is replaced check for a short on the +5VA supply by measuring the resistance from CR41 cathode to ground before applying power to the circuit

L.4.3.3.9 DS14 not illuminated

This indicates that the +5VB supply has failed.

a. Check F6 for approximately +12VDC. If not present refer to the transmitter troubleshooting section to troubleshoot the Low Voltage supply.
b. If F6 checks okay, suspect C156, C155 or U43.
c. If U43 is replaced check for a short on the +5VB supply by measuring the resistance from CR54 cathode to ground before applying power to the circuit.

L.4.3.3.10 DS9 illuminated

This indicates a B+ or B- supply is not active. To discover which is at fault check DS8 and DS10 for illumination when switch S6, on this board, is depressed.

CAUTION

DO NOT HOLD S6 DEPRESSED FOR LONGER THAN 1 MINUTE AT A TIME. THIS WILL PREVENT DAMAGE OR OVERHEATING OF THE REGULATORS.

L.4.3.3.11 DS8 Not Illuminated

If DS8 does not illuminate when S6 is depressed:

a. Check F3 for an open or +12 VDC.
b. If F3 is open check CR49, C62, C64 and U42.
c. If F3 is not open, remove Jumper J13 and depress S6 again while monitoring DS8. If DS8 does not illuminate when S6 is depressed, suspect U42, Q4, C51 or C52. Verify that DS8 will illuminate before installing J13 back in the board.
d. If DS8 Illuminates suspect a short on the B+ line. Then see sheet 3 of the schematic for the IC and bypass capacitors and also check the Air flow sensor and CR55.
e. If +12 Volts is not present on F3 refer to the transmitter troubleshooting section for the Low Voltage Supply.

L.4.3.3.12 DS11 Not illuminated

If DS11 is not illuminated when S6 is depressed:

a. Remove J13 and depress S6 again.
b. If DS11 illuminates suspect a fault on the B- line. Refer to the schematic to locate the components involved.
c. If DS11 does not illuminate measure the voltage on TP22. It should be approximately -12VDC.
d. If this voltage is not present refer to the overall troubleshooting section to troubleshoot the Low Voltage supply.
e. IF TP22 measures correctly check F4.
f. If F4 is open suspect CR50, C60, C61 and U45.
g. If F4 is not open carefully remove U44 from its socket and depress S6 again.
h. If DS11 illuminates Replace U44.
i. If DS11 does not illuminate, suspect U47 or U45 and associated components.

L.4.3.4 Supply Fault Sensing

If all supply indicators illuminate properly, suspect the fault sensing circuit. To begin:

a. Check for a logic low on the cathode of CR57.
b. If the low is not present the board is not generating the fault. Refer to the overall wiring diagram, Transmitter interface schematic and the Controller section as needed to trace the fault.
c. If CR57 is low, observe if DS9 is illuminated.
d. If DS9 is not on, check Q5, C54 and CR57.
e. If DS9 is not illuminated suspect U37 or U49 associated components.

L.4.3.5 RF Amp Turn On

L.4.3.5.1 All Off In Column

If all of the RF amps that are controlled by an encoder board will not turn on, then:

a. Observe that all supply indicators are illuminated when the transmitter is turned on.
b. If not refer to the supply troubleshooting portion of this section.
c. If the supply checks correctly, check TP3 for Data strobe signals.
d. If not present, check U15 and cabling from the Transmitter Interface board.
e. If the Data strobe is present check DS1 and/or TP4 for a logic low.

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f. If the low is present verify that an RF mute has not been selected by the Controller or Remote control.

g. If no RF mute is being given then suspect one of the IC Latches is pulling the line low. The latches can be removed one at a time to locate the failed one.

L.4.3.5.2 One or Scattered Amps With No Turn On

a. First verify that the amp is not at fault by moving the module to another compartment.

b. If the amp checks okay, then see the Mod Encoder Counting Order diagram (843-5155-162) in the Drawing Package to trace the signal flow to the module.

As an example: RF amp 85 does not turn on. The signal flow from the diagram indicates that the path is RF85 to P2-1 to U23-7 to U22-2 to U26-11. To troubleshoot this example:

a. Check for a turn on pulse at U23-7.

b. If present suspect cable or Combiner Motherboard.

c. If not present, check U22-2 for a logic high turn on.

d. If present check P2 and U23.

e. If not present check U26-11 for a logic high.

f. If present replace U22.

g. If not present replace U26.

NOTE

The Latches and EPROMs can be swapped to another location on the board to verify whether they are operating correctly.

L.4.4 Removal and Replacement

Remove the mounting screws and cables to remove the board from the transmitter. When replacing the board, ensure that the Jumpers JP1-JP5 and Plugs P5 and P6 are in the correct position for the location of the board.

L.4.5 Alignments

L.4.5.1 Air Flow Calibration

a. Operate the transmitter at 100 kW with normal program material.

b. Measure the DC voltage at TP7 on the board. This voltage should be +2.5VDC with the front door closed.

c. If it is not adjust R213 Air Flow Calibration on the board until the voltage at TP7 is +2.5VDC.

L.4.5.2 B- Supply

Set B- pot R150 for the Factory Test Data value as measured on TP11. If the test data is not available coarse set this for - 6VDC and refer to the Analog Input Section to align the B-.

WARNING: Disconnect primary power prior to servicing.

L.5 Binary Modulation Encoder (A25)

L.5.1 Introduction

This section describes the Binary Modulation Encoder board. Topics include Function, Location, Block Diagram Description, and Detailed Circuit Description.

NOTE: Parts List for this board is in Section VII.

L.5.2 Function

A25 controls the Big Steps RF125-RF151/RF156, Binary Amplifiers B9-B12 and monitors the Air Flow in the right PA compartment.

L.5.3 Location

Mod Encoder A25 is located in the right PA compartment (SEE VIEW 10).

L.5.4 Block Diagram Description

Refer to the block diagram description for the Big Step Modulation Encoders, A26-A29.

L.5.5 Detailed Circuit Description

The following description will only contain information on the differences in the Binary Modulation Encoder A25, which is designated by the dashed lines on the drawing.

L.5.5.1 Binary Encoder

The Binary RF Amplifiers are directly controlled by the four Least Significant Bits of the Digital Audio Signal, B9 through B12.

L.5.5.1.1 Input Latches

B9 through B12 enter the board on J8-1 through J8-7 (odd numbered connections). They are connected to the input of Data Latch U17 on pins 14, 13, 8, and 7 which latches the data when a Data Strobe signal is present. The output of U17 is distributed to another Latch U18 that is connected to OR gates.

L.5.5.1.2 OR Gates

The other input of the OR gate U19 comes from the Binary Clip circuit. Normally this input is low and the Binary RF Amps are controlled by B9-B12.

If the bit is high, then the associated Binary RF Amp is turned ON. If the bit is low, then the associated RF Amp is turned OFF.

L.5.5.1.3 P1B

In order for the board to control the Binary RF Amps, it is necessary for jumper P1 to be installed in the P1-B position. This will distribute B9 to J1-17, B10 to J1-15, B11 to J1-13 and B12 to J1-11. The other four positions are used by U5 to control Big Step RF Amps 133 through 136.

L.5.5.1.4 Connector Inversion

Connectors J3 and J4 are physically located on the back side of the board and are offset by one pin to accommodate the control of the other Big Step RF Amps.

L.5.5.2 Binary Clip PAL

The Binary Clip PAL produces a flat topped positive peak modulation if the audio input level exceeds the maximum positive peak modulation capabilities of the transmitter.

When all Big Step and Binary RF Amps are turned ON, a further increase in audio input will hold all Binary RF Amps ON.

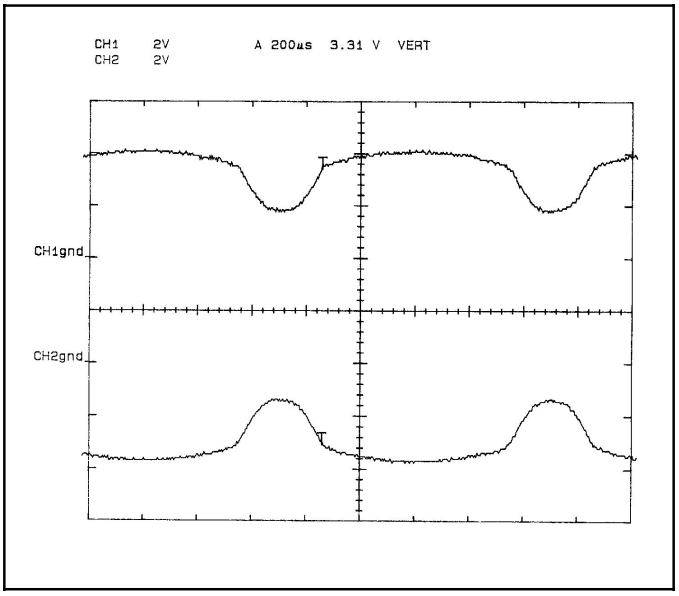
Binary Clip PAL U2-20 will go high and is connected to all inputs of OR gate U19 via JP3-5.

This high input holds all OR gate outputs high and all Binary Steps ON, as long as the CLIP signal is present.

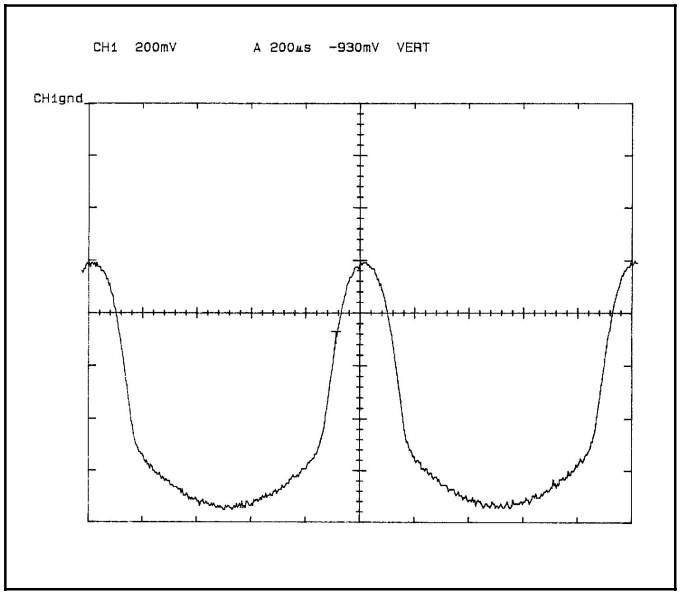
When the audio input level returns back to normal, the Clip output will go back low and the Binary RF Amps are controlled again by B9-B12.

L.5.5.3 Binary RF Amplifier Failure

If a Binary Step fails it is necessary to turn the Transmitter OFF and physically replace the failed Binary Amp. If a spare is not available,



CH1 J7-3
CH2 J7-1



TP15

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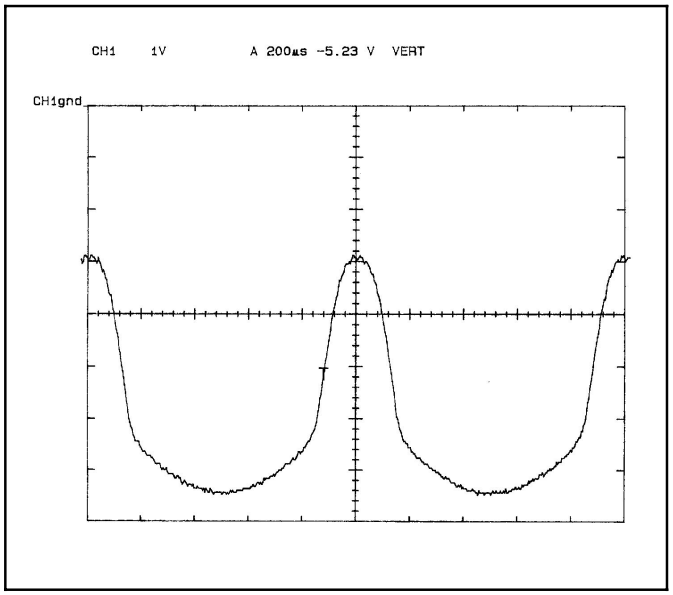
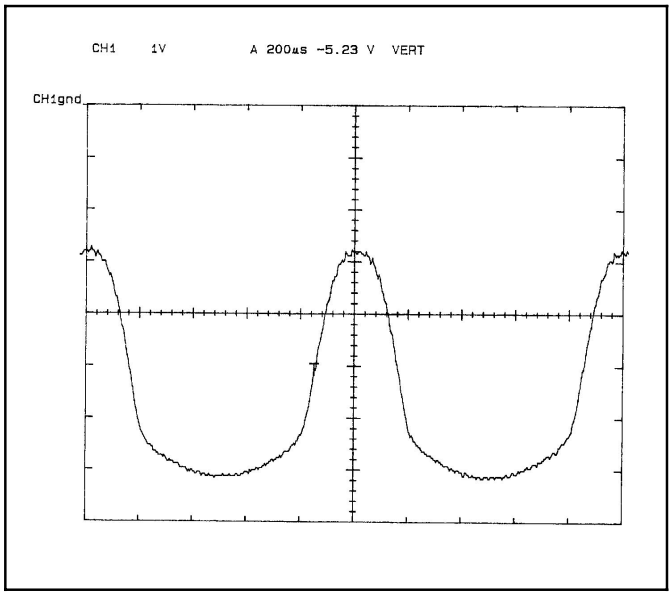
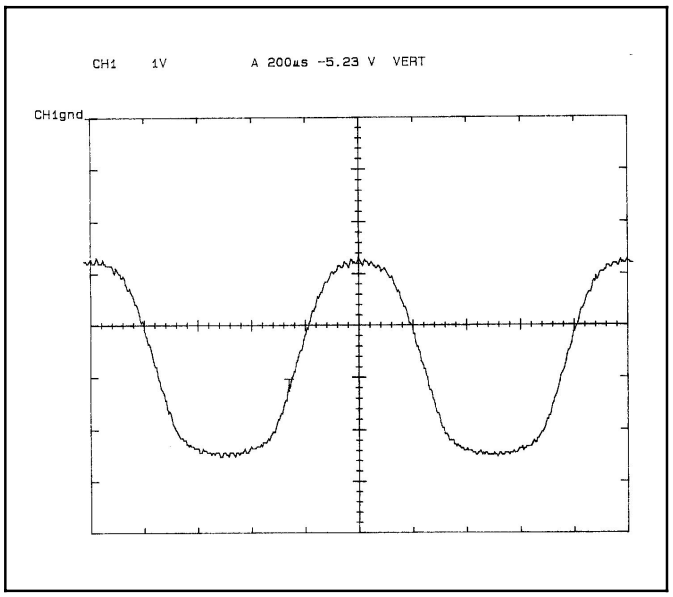
move the RF Amp in Step 156 to the faulty Binary location. Then place the failed RF Amp in the Step 156 location.



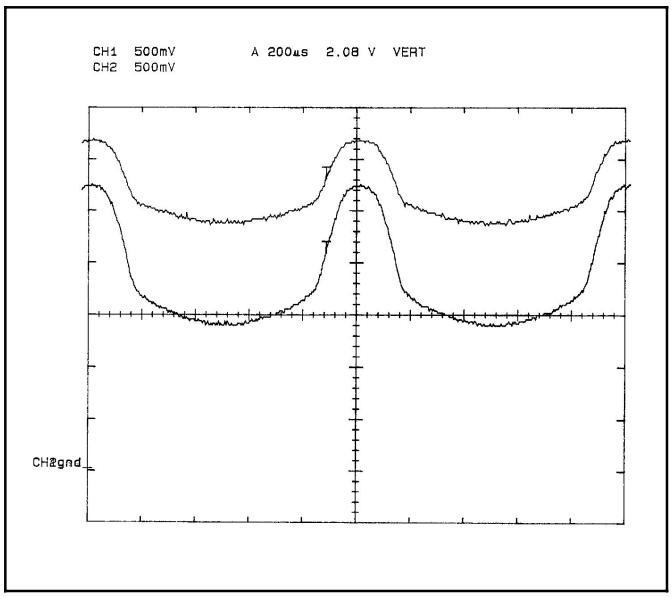
TP11



TP11 (50kW)



TP11 (10kW)



Upper Trace CH1 U37-11
Lower Trace CH2 U37-10

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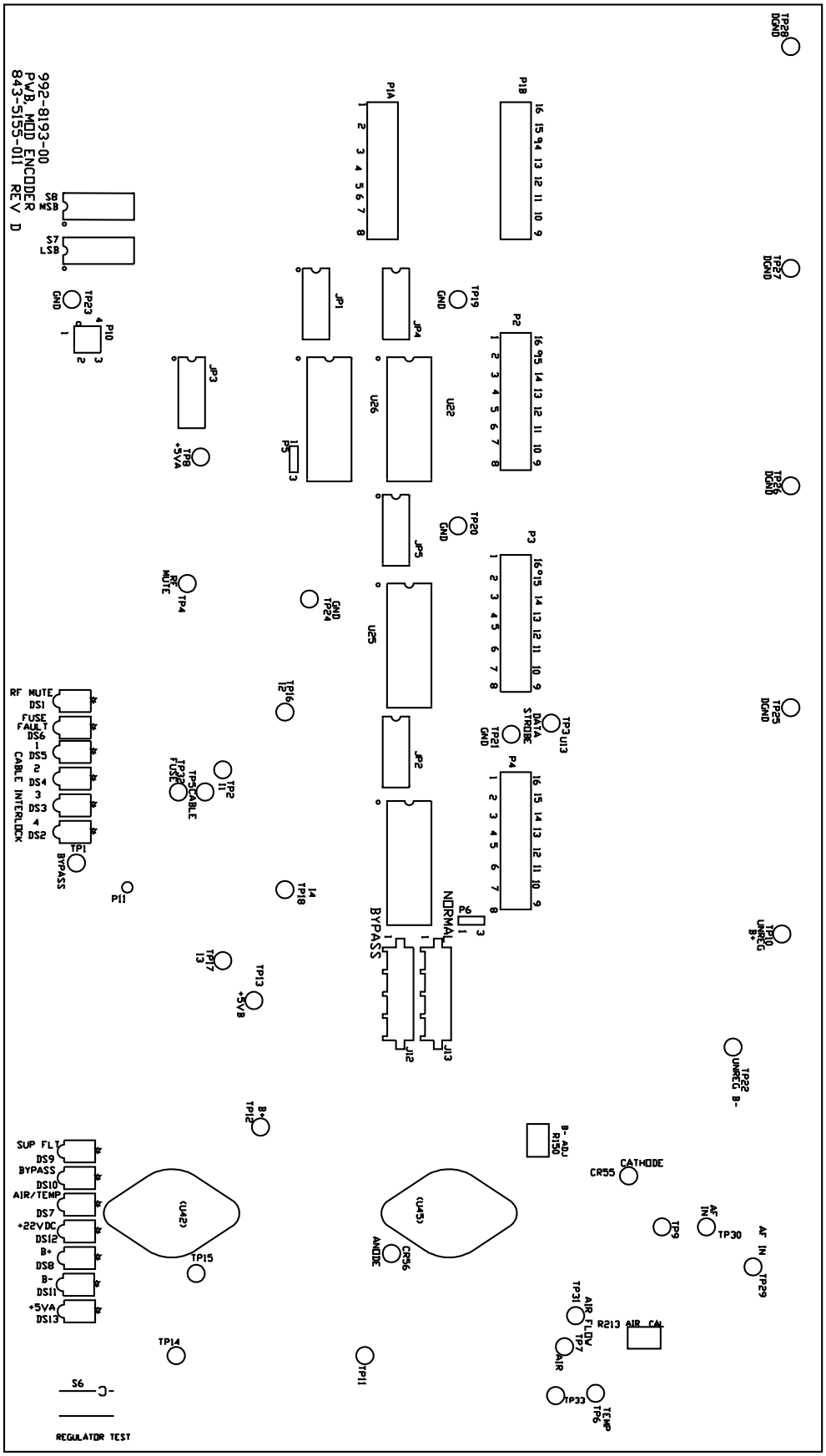

Figure L-4. Modulation Encoder Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

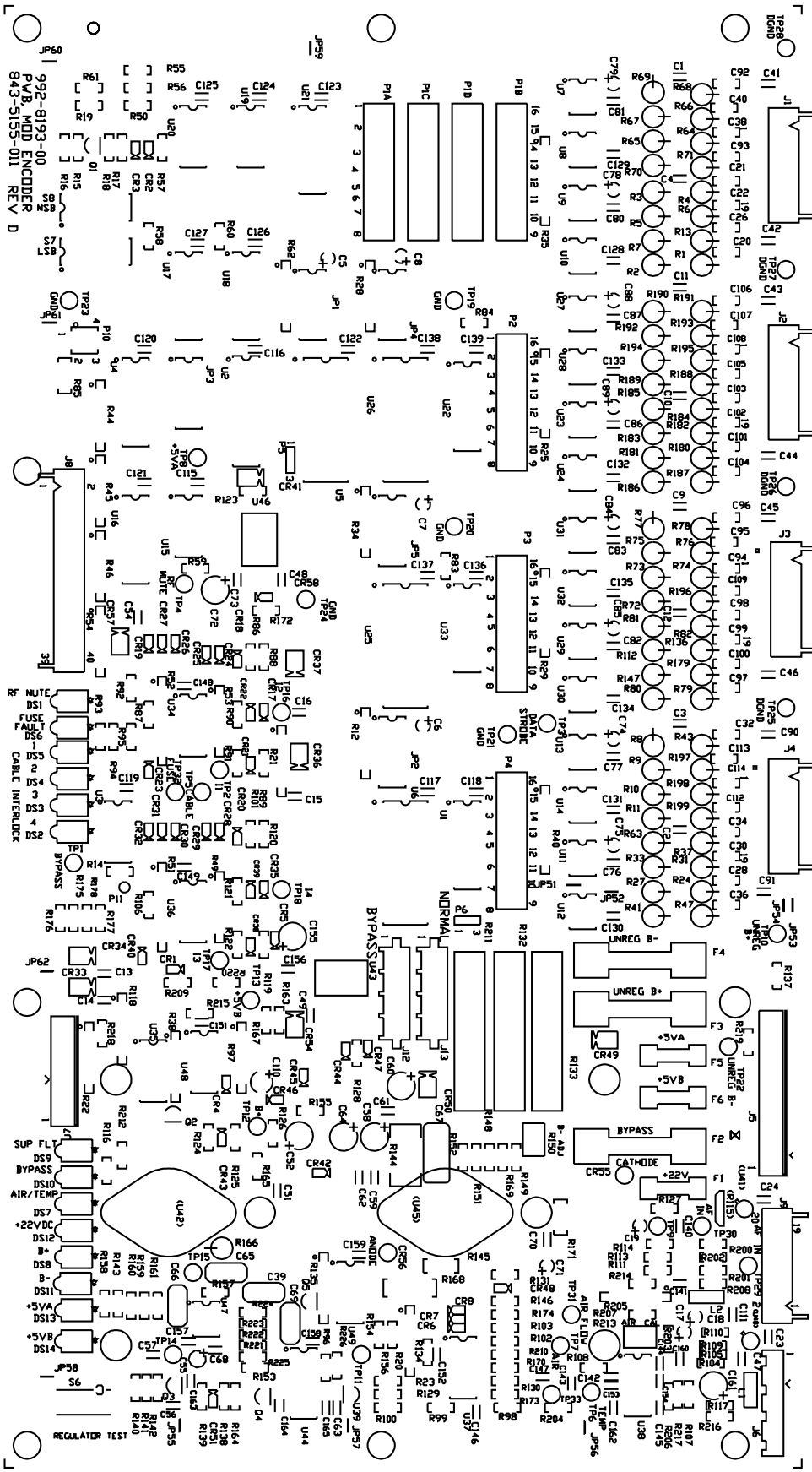

Figure L-5. Modulation Encoder Component Locator

WARNING: Disconnect primary power prior to servicing.

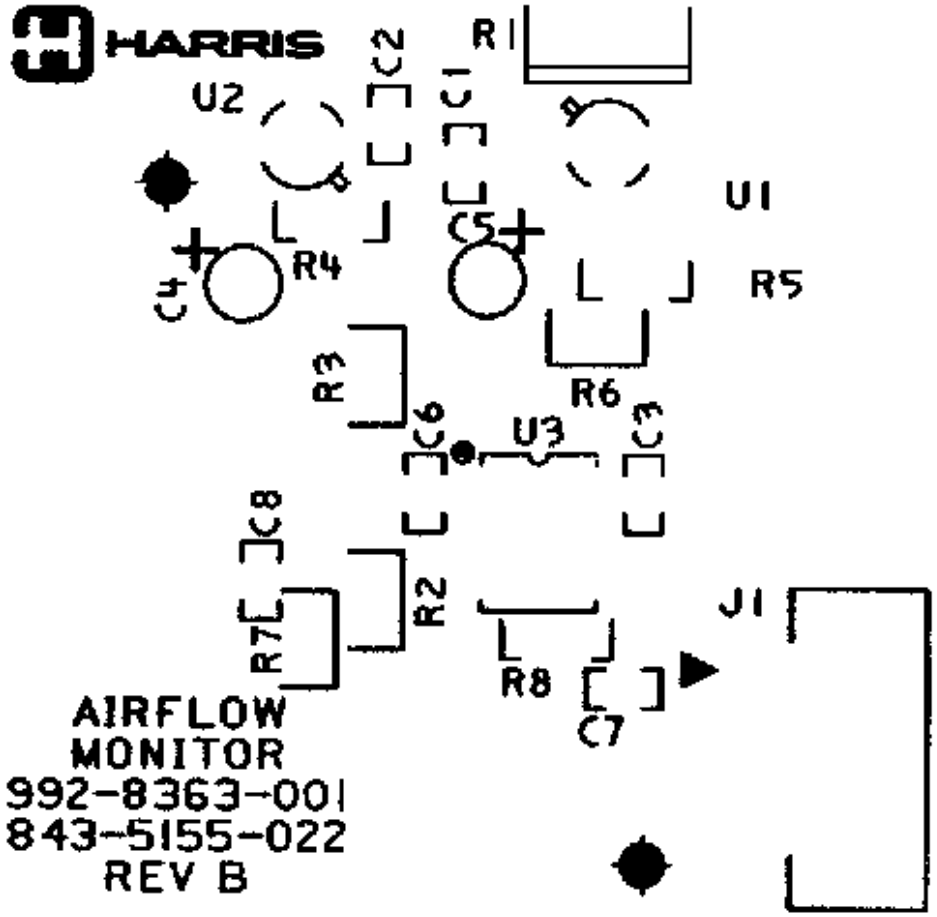

Figure L-6. Airflow Monitor Component Locator

WARNING: Disconnect primary power prior to servicing.

M.1 Introduction

This section describes the Controller board. Topics include Function, Location, Block Diagram Description, Detailed Circuit Description, Troubleshooting, and Removal/Replacement.

NOTE: Parts List for this board is on Section VII.

M.2 Function

The purpose of the Controller is to provide Local/Remote Step-Start Sequence control of the Low/Med/High power levels, monitor transmitter operation and protectively respond to external or internal fault conditions, and provide metering functions in addition to status indicators.

M.3 Location

The Controller board is located on the back of the center control compartment front door (SEE VIEW 13).

M.4 Block Diagram Description

The Controller uses PAL integrated circuits (Programmable Array Logic). These PALs are grouped to perform various functions. PALs are devices that can be programmed to implement complex logic functions with up to twenty-two inputs and ten outputs. The 22V10 PAL used in the transmitter uses AND/OR logic array structure, which directly implements sum-of-products equations. The equations are programmed into the device through electrically-erasable floating-gate cells in the AND logic array. The fixed OR logic array offers a varied number of product terms per output and can be programmed as registered active high or active low.

Refer to Figure M-1 Controller Power Control Block Diagram for the following discussion.

M.4.1 Power Level Selection and Power Lower/Raise Control - OPR and LR PALs

These PALs work together to generate the Turn On Request when a power level is selected, control the Lower/Raise function, and produce the VSWR Test signal when required.

The OFF, LOW, MED, HIGH, LOWER, and RAISE control inputs from the External Interface board are processed by the OPR (Operator) PAL and the LR (Lower/Raise) PAL.

These same inputs from the Switch board on the front panel are applied to Transistor Inverters and connected to the OPR and LR PALs.

If there are no present faults, the ENTOR (Enable Turn On Request) from the FLT1 PAL will allow the LR PAL to generate a TOR (Turn-On Request) when a power level is selected. This TOR is sent to the PWR and PTIM PALs.

Both PALs provide outputs to the Switch board, External Interface, and to the Analog Input board for status and control functions. Transistor Inverters provide the proper voltage levels for operation.

During power level selection, power level change, or by a Manual VSWR Test, the LR PAL generates the VSWR Test signal that is used by the Output Monitor board. The Pass/Fail results of this test are determined on the Output Monitor board.

After the transmitter is operational on the selected power level, the Lower/Raise controls are activated and fine power level changes can be made to the transmitter.

M.4.2 Step-Start Sequence Control - PWR and PTIM PALs

These PALs work together to generate the Step-Start Sequence outputs to the transmitter and the Enables used by the Fault Handling PALs on the Controller.

When a Turn-On Request (TOR) is received by both the PWR (Power) and PTIM (Power Timing) PALs, the PTIM PAL starts the initial sequence by sending a Time pulse to the PWR PAL 1.5 seconds after the TOR is produced.

The PWR PAL sequentially controls the Step-Start function by activating Relay Driver Transistors that control relays in the RF Amp Power Supply and activating the TX ON Enable that is used by several other boards in the transmitter.

When the relays close sequentially, the Low Voltage Supply Sensing and Status signals tell the PWR PAL the transmitter has responded properly and it is acceptable to go the next step.

The PWR PAL must receive Time signals from the PTIM PAL, before executing each step.

The PWR PAL also generates the Enable 1, Enable 2, and Enable 3 signals that are used by the Fault Handing and Latch PALs.

An 8 kHz Clock is Divided down several times to provide six different clock frequencies used by different PALs.

Refer to Figure M-2 Controller Fault Handling Block Diagram for the following discussion.

M.4.3 Fault Types and Fault Input Latches

All fault inputs generated by the transmitter are applied to Fault Input Latches and can be categorized by the type of Controller response:

RF MUTE

This type fault will lower the power to zero by turning all Big Step and Binary RF Amplifiers OFF, but it does not to turn the transmitter OFF.

FOLDBACK FAULT

Foldback faults will reduce the power output in steps, the amount of attenuation is determined by the type and length of the fault. If

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the original fault is of short duration or no longer present, the transmitter can recover in steps back to the original power. If the transmitter is at maximum foldback, and another power reduction is requested, then the transmitter will be shut off.

A/C RESTART FAULT (FACR)

If the A/C power is lost, the transmitter will turn OFF and wait for the A/C to return to normal. When it does, the transmitter will automatically turn back ON at the same power level output as before.

OVERLOAD FAULT (FOVR)

This type fault turns the transmitter OFF, the Controller attempts once to recover when the fault is removed. If the fault is not present on the retry, the transmitter will remain ON. If the fault is still present on the retry, the transmitter will turn OFF and remain in this condition until restarted by an operator after the fault has been corrected.

FAULT OFF (FOFF)

This type fault will turn the transmitter OFF, and the transmitter must be restarted by an operator after the fault has been corrected.

M.4.4 Power Foldback/Recovery Control - FLDBK and FBTIM PALs

These PALs work together to respond to Foldback Faults by controlling the transmitter power output.

Faults that require Foldback/Recovery are applied to the FLDBK (Foldback) PAL. Outputs DB1,2,3 are used to vary the transmitter power output level via controls on the Analog Input board.

The FBTIM (Foldback Timing) PAL receives the Status of the FLDBK PAL. It sends timing signals for the Down Timing (Foldback) and the Up Timing (Recovery) to the FLDBK PAL.

If the maximum amount of Foldback is not enough to protect the transmitter, Foldback Limit will upgrade the fault to a Fault OFF fault.

M.4.5 RF Mute Faults - FGATE 1

Faults that require the power output to be set to zero, but not to turn the transmitter OFF are applied to FGATE 1 (Fault Gate 1).

These RF Mute faults, manual RF Mute, or requests from the FLT1 PAL are generated by this PAL and sent to the Transmitter Interface where it is distributed to several boards.

M.4.6 OFF-A/C Restart-Overload Faults - FGATE 2

These faults or manual Fault Switches designed to simulate the faults are connected to the FGATE 2 (Fault Gate 2) PAL.

The PAL categorizes these faults into FOFF, FACR, or FOVR and applies them to the FLT1 PAL for transmitter control.

M.4.7 Fault Handling - FLT1 and FTIM

These PALs work together to control the transmitter response to these three fault types.

The FLT1 (Fault 1) PAL accepts the FOFF, FACR, and FOVR faults from FGATE2 and the Foldback Limit from FLDBK.

It responds to these faults by controlling the Enable Turn-On Request that is sent to the LR PAL. ENTOR signals the LR PAL that no inhibitive faults are present. Conversely, loss of ENTOR recoverably faults the transmitter OFF.

The FTIM (Fault Timing) PAL provides the Timeout signals to FLT1 based upon the Status of the fault in progress.

FLT1 is the source of the FLT Master Reset that is connected to most PALs. When activated, this signal halts all activity and clears the PALs to their off or ready state.

M.4.8 Latch PALs and Fault LED Latches

All fault inputs can be registered by the three Latch PALs when the appropriate Enable is activated.

The purpose of the Latch PALs and Fault LED Latches is to hold or store a fault that has occurred so that it can visibly illuminate an indicator on the LED Board and provide Summary Faults to the External Interface.

Refer to Figure M-3 Controller Power Supplies/Monitoring Block Diagram for the following discussion.

M.4.9 Controller Power Supplies

The +12VDC supply powers two +5VDC Regulators that are diode “OR”ed together to form the +5VDC supply. Should either regulator fail, the other regulator is capable providing all the required current. A Voltage Detector will generate a Controller Supply Fault that only provides a visual indication of the fault.

If the single phase A/C power fails, an Unregulated Supply Loss Detector will create a Controller Unregulated Loss Fault. This is an A/C Restart Fault that will also turn LEDs off to conserve power via the Supplies Present Detector and the LED Inhibit.

A Backup Capacitor will hold up the +5VDC supply for about 10 minutes. If the Backup Capacitor voltage begins to drop too low, a Backup Voltage Detector and Battery Backup Switch will connect +6VDC from the Battery Backup on the Transmitter Interface to the Controller +5VDC supply. This will hold up the +5VDC supply for about four days.

Another +5VDC Regulator is used to supply circuits on the Transmitter Interface.

M.4.10 Controller Monitoring

A sample of the RF Amp Power Supply is connected to an Overvoltage and Undervoltage Detector that can create a Power Supply Voltage Error if the voltage is not within the required limits.

When the transmitter is in the STANDBY Mode, the LV supplies are active. +8 VDC is connected to the Low Voltage Supply Sensing circuit which generates a high KLVX output signal that is used by the PWR PAL. When the transmitter is in the Standby Mode, the LV supplies are not active. The KLVX output will be low.

A Remote Control Input, Control front panel Fault Reset, or the onboard Reset switch is used by the Reset Detector to produce the Reset used by the Controller.

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M.5 Detailed Circuit Description

Refer to the Controller Schematic Diagram (839-7930-021), for the following discussion.

Refer to other Simplified Diagrams as requested.

NOTE

On all Simplified Diagrams if a bar is placed over the top of the input or output mnemonics, this designates the function as an active low signal. When the signal is low, the function is activated. If no bar is placed over the top of the mnemonic, the function is an active high signal. When the signal is high, the function is activated.

NOTE

All inputs/outputs to/from the Controller are fully transient and overvoltage protected as well as RFI filtered. This is accomplished by use of resistor voltage dividers (10k and 100k Ohm), zener diodes (5.1VDC), and capacitors (.001uF).

M.5.1 LR and OPR PALs

M.5.1.1 Switch Board And External Interface Inputs

From the transmitter front panel Switch board, High, Medium, Low, Off, and Raise and Lower power level control buttons provide active high inputs to the Controller on J3-30 through J3-35. These inputs are buffered by transistor inverters U40 and U41, and passed to the LR and OPR PAL as active low signals labeled XXX.IN (example HIGH.IN, MED.IN, etc).

From the External Interface Board, the same extended/remote control inputs provide active low inputs to the controller on J4-9, 11, 13, 15, 17, and 19. They are enabled by the Local/Remote Control front panel switch and operate identically to the front panel switches. These active low signals are paralleled with the Switch board inputs.

Refer to Figure M-4, LR and OPR PALs.

M.5.1.2 Power Level Selection

When a power level is selected, the corresponding XXX.IN to the OPR PAL will go low.

Gating logic and a Priority Selector in the OPR PAL will generate a latched Off, Low, Med, or High logic high output that is sent to the Lower/Raise (LR) PAL and Local/Remote Transmitter Status Output transistors.

If multiple XXX.IN inputs go low simultaneously, only a single OFF, LOW, MED, or HIGH command will be generated (in this order) as determined by the Priority Encoder.

M.5.1.3 Turn On Request Generation

When the power level selection is made, the high input to the LR PAL will generate a high Turn On Request (TOR) as long as the Enable Turn On Request (ENTOR) is high.

The ENTOR comes from the FLT1 PAL, and it must be high for the LR PAL to generate a TOR.

The TOR is applied to the PWR PAL and the PTIM PAL to begin the Step Start Sequence.

When the transmitter is manually turned OFF or if the ENTOR goes low (from a fault condition), the TOR signal goes low and the transmitter is shut OFF.

M.5.1.4 Local/Remote Transmitter Status Outputs

When the power level selection is made, the corresponding Low Med or High, logic high output from the OPR PAL will directly send a high output signal to the Analog Input board via J1-27, 29, or 31. This will activate the Power Control switch on the Analog Input board that controls the power output.

This logic high signal will also turn on a transistor inverter U42 that sends a low signal to illuminate the lamp inside the pushbutton switch on the Switch board and activates the Remote Status Output on the External Interface board.

The outputs to the Switch board are on J3-25, 26, and 27. The outputs to the External Interface are on J5-3, 5, and 7. A convenient place to measure these active low signals are at TP10 (HIGH), TP11 (MED), and TP12 (LOW).

When the transmitter is OFF, an inverter transistor pulls TP13 low and this signal is sent to the External Interface board via J5-1.

M.5.1.5 Lower/Raise Fine Power Control

After Enable 3 has been generated by the PWR PAL, and as long as the Keypress is low, the LOWER.IN and RAISE.IN inputs to the LR PAL are active. The Priority Select circuit gives the Lower command priority over the Raise command if both inputs are low at the same time.

The active logic high LOWER output is sent to the Analog Input board via J1-1 to control the Fine Power Control PALs. A transistor inverter U41 pulls TP15 and J3-29 low, which illuminates the lamp inside the pushbutton switch on the Switch board.

The same action occurs for the RAISE output at J1-15, and TP14/J3-28. A transistor inverter U41 pulls TP14 and J3-28 low, which illuminates the lamp inside the pushbutton switch on the Switch board.

M.5.1.6 VSWR Self Test Request

When the transmitter is first turned ON, or the selected power level is changed, or when the Manual VSWR Self Test switch S5 is depressed, the Detect Any Change circuit in the LR PAL generates a VSWR Self Test (VST).

The VST output at U6-18 will go high for 8mS. This turns on Q1 and J7-9 VSWR Self Test Request goes low. This low signal is sent to the Output Monitor for testing the VSWR detectors via the Transmitter Interface. The results of the test are determined on the Output Monitor.

The VSWR Self Test can also be activated by the VSWR Test switch on the Control front panel, which is connected to J2-11 on the Controller.

M.5.1.7 Keypress

Anytime a XXX.IN input is low or if the transmitter is in the process of an A/C Restart, the Keypress - A/C Restart Detector inside the OPR PAL will generate a high Keypress signal. This signal is connected to the LR PAL and inhibits any Raise or Lower command input.

M.5.1.8 Fault Input

If the FLT line Master Reset from the FLT1 PAL goes high, the Priority Select circuit on the OPR PAL is reset and the Operator

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Error (OPR.ERR) output will go low illuminating the OPR PAL Fault Indicator DS3 RED.

On the LR PAL, both the Priority Select and the Detect Any Change circuits are reset and the Lower Raise Error (LR.ERR) will go low illuminating the LR PAL Fault Indicator DS2 RED.

M.5.2 PWR and PTIM PALs

Refer to Figure M-5, PWR and PTIM PALs.

M.5.2.1 Turn On Request

The Turn On Request from the LR PAL is used to start the Step-Start Sequence. When the PTIM PAL receives this signal it starts the Turn On Sequence Timer that generates a high output TIME pulse 1.5 seconds later. This first Time pulse is sent to the PWR PAL which tells it to go to the Ready State.

M.5.2.2 Step Start Sequence Control

The following is a shortened version of the Turn-On Sequence, refer to the Turn On Sequence at the end of this section for a more detailed explanation. Refer to the Step Start Sequence Chart as needed.

When the PWR PAL is in the ready state, Time pulses from the PTIM PAL Turn On Sequence Timer tell the Turn On Sequence Controller in the PWR PAL to execute the next step.

The following outputs from the PWR PAL are activated in this order:

M.5.2.2.1 KLV

This signal turns on the low voltage power supply(s) and they begin to charge up. The high signal is also sent back to U8-6 to tell the PTIM PAL that KLV is activated. When the +8 VDC supply is charged up, the output of the Voltage Supply Sensing comparitor KLVX will go high allowing the Turn On Sequence Controller to go to the next step.

M.5.2.2.2 MODENC

This signal is sent to the Transmitter Interface and called the TX ON ENABLE-H. It controls functions on the Modulation and Driver Encoder boards and the Output Monitor.

M.5.2.2.3 Enable 1

This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FGATE2 in addition to clocking the Latch PAL U-12. The high signal is also sent to U8-7 to tell the PTIM PAL that Enable 1 is activated.

M.5.2.2.4 K1

This signal will turn on the Step Start contactor K1, and remains high for 1.7 seconds. The high signal is also sent to U8-4 to tell the PTIM PAL that K1 is activated. An auxiliary contact on K1 sends a high signal back to the Controller called K1X.X that allows the Turn On Sequence Controller to go to the next step.

M.5.2.2.5 Enable 2

This signal is used by the Controller to activate some fault inputs connected to FGATE1, FGATE2, FLT1, and the FLDBK PALs in addition to clocking the Latch PAL U-11. The high signal is also sent to U8-8 to tell the PTIM PAL that Enable 2 is activated.

M.5.2.2.6 K2

This signal will turn on the Run contactor K2. The high signal is also sent back to U8-3 to tell the PTIM PAL that K2 is activated. An auxiliary contact on K2 sends a high signal back to the Controller called K2X.X that allows the Turn On Sequence Controller to go to the next step.

M.5.2.2.7 Enable 3

This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FLT1 in addition to clocking the LATCH PAL U13. When Enable 3 goes high the RF Mute generated by FGATE 1 is removed.

M.5.2.3 UNFLT

This pulse is generated after the final power-up state is achieved, and every two seconds afterwards. It is used by the FLT1 PAL for overload fault timing.

This completes the Step Start Sequence, and all PAL outputs remain in this condition until loss of TOR or the FLT input is activated.

M.5.2.4 Loss Of TOR

Response to a loss of the TOR (an OFF command or fault condition) is independent of these inputs and the transmitter is sequentially shut down. The Turn-On Sequence Controller and the Turn-On Sequence Timer are reset.

M.5.2.5 K2 Overload Fault

If the K2X.X auxiliary contact signal is not received by the PWR PAL, an internal NAND gate will generate a low K2OV signal. This K2 Overload is sent to the FLT1 PAL and is treated as a special Overload Fault.

M.5.2.6 Fault Input

If the Master Reset FLT line from the FLT1 PAL goes high, the transmitter is shut down and both the Turn On Sequence Controller and the Turn On Sequence Timer are reset.

M.5.2.7 Error Output

PWR ERR (PWR Error) continuously monitors the Turn-On Sequence Controller for erroneous states.

M.5.3 Fault Input Latches

All fault inputs generated by other boards in the transmitter are connected to either J1, J6, J7, or J8 and are applied to Fault Input Latches U21 through U25. All faults are active low inputs, meaning that if the input is low the fault condition is present.

The purpose of the Fault Input Latches is to hold the fault so the Fault Handling PALs can properly respond to the input. They are clocked by FCLK0 (Fault Clock 0) which is the 4kHz clock that has been inverted by the FGATE1 PAL.

Once the fault input has been latched it is designated as Abbreviated Fault Type.X. For example, once the Predriver Fault-L input at J6-17 is latched by U21 - it is then called PD.RF.X. From the output of the latches, each fault type is distributed to the appropriate Fault Handling PAL.

M.5.4 Fault Handling

As explained in the Block Diagram Description, fault types are broken down into four categories depending upon the Controller

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response to the fault. Each category has PAL(s) assigned to handle the fault type.

M.5.5 RF Mute - FGATE1 PAL

Faults that require the power output to be set to zero, but not to turn the transmitter OFF are applied to FGATE 1 (Fault Gate 1).

When an RF MUTE is generated by FGATE 1, it will turn all Big Step and Binary RF Amplifiers OFF by setting all latches on the Modulation Encoder boards to zero.

Refer to Figure M-6, FGATE 1 PAL.

FGATE 1 PAL contains multiple input/single output RF Mute Logic. When any one of the inputs is low (with the exception of Enable 3), the RF MUTE A output will also be low.

M.5.5.1 Transmitter RF MUTE Faults

The following are RF MUTE faults and their abbreviations.

OSCILLATOR FAULT	OSC.RF.X
BUFFER AMP FAULT	BR.RF.X
PREDRIVER FAULT	PR.RF.X
OUTPUT MONITOR NETWORK VSWR	OM.ON.X
OUTPUT MONITOR ANTENNA VSWR	OM.AV.X
OUTPUT MONITOR SUPPLY FAULT	OM.SF.X
ANALOG INPUT SUPPLY FAULT	AI.SF.X
A/D SUPPLY FAULT	AD.SF.X
A/D CONVERSION ERROR	AD.CE.X

M.5.5.2 Controller RF MUTE

A Manual RF MUTE can be applied by moving S1 to the MUTE position. This will apply a low to the MUTE PB input, and is used for troubleshooting purposes.

When the FLT 1 PAL is responding to FOFF, FOVR, or FACR faults, it will generate a MUTE Request that will generate an RF MUTE during the duration of the fault handling.

During the Step Start Sequence, an RF MUTE is generated until Enable 3 goes high. The purpose of this is to hold all Big Step and Binary RF Amplifiers OFF during the time that the RF AMP Power Supply is charging up.

M.5.5.3 RF MUTE Summing

The RF MUTE A output from FGATE 1 PAL is summed together with RF MUTE lines from the A/D Converter board at J8-5 and the Analog Input board at J1-9.

The RF MUTE A also is connected to the FLDBK PAL however currently there is no action taken by the FLDBK PAL.

The RF MUTE used by the Modulation Encoder boards is connected to the Transmitter Interface at J7-21.

The MUTE LED signal is latched by U25-16 and labeled MUTE.LED.X. It is passed on to the Fault LED Latching circuits formed by U33 and U34 and eventually is sent to the LED board at J2-15 and labeled RF MUTE.Q. When the transmitter is OFF an RF MUTE is still applied, however diode CR21 pulls the line high so the Control front panel Controller RF MUTE LED is illuminated GREEN.

M.5.5.4 Clock Inverters

There are two inverters connected to the 4kHz clock that are used to generate FCLK0 and FCLK1. Fault Clock 0 is used by the Fault Input Latches and Fault Clock 1 is connected to the Transmitter Interface at J7-19 where it is sent to the VSWR PAL on the Output Monitor board.

M.5.6 Power Foldback/Recovery Control - FLDBK and FBTIM PALs

Faults that require the power output to be reduced/increased are applied to the FLDBK (Foldback) PAL. The FBTIM (Foldback Timing) PAL provides timing signals used by the FLDBK PAL.

When a fault occurs, the power output is reduced in steps and this condition is called Foldback. The amount of attenuation from the selected power level is determined by the type and length of the fault.

If the original fault is no longer present after a certain level of Foldback, the power output will be increased in steps back to the original power level. This is called Recovery.

When Foldback/Recovery is generated by the FLDBK PAL, it will control a resistive attenuator switch U12 on the Analog Input board.

Refer to Figure M-7, FLDBK and FBTIM PALs.

The following are Foldback faults and their abbreviations:

NETWORK VSWR	OM.ON.X
ANTENNA VSWR	OM.AV.X
AIR FLOW REDUCED	AF.R.X
OVERTEMP FOLDBACK	OT.FB.X

M.5.6.1 Foldback/Recovery Outputs

Depending upon the type and length of fault, the Foldback Controller in the FLDBK PAL can be up to 8 different Foldback/Recovery levels.

The outputs that are used to control the amount of Foldback/Recovery are called DB1, DB2, and DB3. They are sent to the Analog Input board via J1-17, 19, and 21 respectively.

If the transmitter is not in Foldback, these outputs will all be low. If Foldback/Recovery is in progress, the following chart lists the amounts of attenuation and the DB 1, 2, and 3 logic levels.

Foldback Level	DB1	DB2	DB3	Power
0dB	L	L	L	100kW
-.5dB	H	L	L	89kW
-1.0dB	H	H	L	79kW
-2.0dB	L	H	L	63kW
-3.0dB	L	H	H	50kW
-6.0dB	H	H	H	25kW
-10.0dB	H	L	H	10kW
-12.0dB	L	L	H	6kW

M.5.6.2 VSWR Foldback

Antenna or Network VSWR faults are treated the same, for discussion purposes the Antenna VSWR fault will be described.

The Foldback Controller can not respond to these faults until Enable 2 has been generated by the PWR PAL (FGATE 1 is generating an RF MUTE until Enable 3 goes high, which occurs after Enable 2, so this fault can not occur prior to Enable 2).

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If the VSWR PAL on the Output Monitor receives five Antenna VSWR pulses within a 20 second period, the OM.AV.X line will go low for 250 uS.

The Foldback Controller will immediately (within 250 uS) Foldback the power -.5dB.

If additional 250 uS OM.AV.X low pulses are received, the Foldback Controller will continue to step down the power level until the pulses stop (Antenna VSWR fault ends) or until the Foldback Limit output goes high and shuts OFF the transmitter.

The following chart lists the Foldback levels for VSWR faults.

ATTEN	MINIMUM TIME
0dB	
.5dB	7.5 Seconds
1dB	7.5 Seconds
2dB	7.5 Seconds
3dB	7.5 Seconds
6dB	7.5 Seconds
10dB	7.5 Seconds
12dB	7.5 Seconds
OFF	

When the first Foldback level occurs, the Down output from the Foldback Controller goes high for 250 uS and starts the 4 Minute Foldback Down Timer in the FBTIM PAL.

If additional Foldback levels occur, the Down output will continually reset the 4 Minute Timer.

Once Foldback has reduced the power output to a safe operating level (assuming it has not shut OFF), the offending fault will no longer be present at the input.

After 4 minutes, the DNTIM (Down Timing) output from the FBTIM PAL will go high for 250 uS. This pulse is sent back to the Foldback Controller and signals it to check the fault input again.

When the Foldback Controller sees that the fault input is high, it will generate a 250 uS Up pulse that starts the Recovery process.

M.5.6.3 VSWR Recovery

When Recovering from Foldback, the Recovery time to the next highest step is 4 minutes. For example, if there has been a -6dB Foldback - it will take 20 minutes to Recover back to 0 attenuation.

The following chart lists the Recovery levels for VSWR faults.

ATTEN	MINIMUM TIME
0dB	
.5dB	4 min.
1dB	4 min.
2dB	4 min.
3dB	4 min.
6dB	4 min.
10dB	4 min.
12dB	4 min.

If the transmitter folds back to OFF there is no automatic recovery. The transmitter must be activated by selecting a power level.

When the Foldback Controller generates the first 250 uS Up pulse it will also Recover to the next step of less attenuation.

The Up pulse will start the 4 Minute Recovery Timer in the FBTIM PAL, which will sent a UPTIM (Up Timing) back to the Recovery Controller.

This UPTIM pulse will cause the Recovery Controller to move to the next step of less attenuation and generate another Up pulse to restart the 4 Minute Recovery Timer.

This process will continue in 4 minute steps until the attenuation is 0dB.

M.5.6.4 Temperature Foldback

Temperature Faults that can cause Foldback originate from the following sources:

a. The RF Amp temperature sensor on Big Step #1 (sensed on Modulation Encoder board A29).

b. The RF Amp Power Supply temperature sensors on the rectifier heat sinks (sensed on the Driver Encoder).

c. The Ambient temperature sensor on the Transmitter Interface board (this fault will illuminate the RF AMP TEMP indicator on Control front panel).

These three faults are summed together on the Transmitter Interface board, sent to the Controller at J7-33, and called Overtemp Foldback-L. Once latched, the fault is called OT.FB.X.

The Foldback Controller can not respond to this fault until Enable 2 has been generated by the PWR PAL.

The Foldback process for the Temperature Fault is basically the same as for VSWR with only two differences.

First, the levels of attenuation are different.

Secondly, when the OT.FB.X input goes low the first level of Foldback is immediate. From this point on, the Foldback Controller will wait 4 minutes to check the fault input again to determine whether to Foldback again or begin to Recover. The reason for this time delay is to allow for thermal time constants (cooling of components).

The following chart lists the Foldback levels for the Overtemperature fault.

ATTEN	MINIMUM TIME
0dB	
3dB	250 uS
6dB	4 min.
10dB	4 min.
12dB	4 min.
OFF	

If Foldback is still insufficient to properly cool the transmitter at the reduced power levels, Temperature Monitoring circuits on the Modulation Encoder board and the Driver Encoder board can still generate an Overtemperature Fault-L (OT.OFF.X)that will turn the transmitter OFF at any time during Foldback.

Refer to the FGATE 2 PAL for more information.

WARNING: Disconnect primary power prior to servicing.

M.5.6.5 Temperature Recovery

The Recovery process for the Overtemperature Fault is the same as for VSWR Recovery.

The following chart lists the Recovery levels for the Over Temperature fault.

ATTEN	MINIMUM TIME
0dB	
.5dB	4 min.
1dB	4 min.
2dB	4 min.
3dB	4 min.
6dB	4 min.
10dB	4 min.
12dB	4 min.

M.5.6.6 Air Flow Foldback

Air Flow Faults that can cause Foldback originate from the following sources:

a. The Air Flow Monitoring on the A25, A26 and A28 Modulation Encoder boards.
b. The Air Flow Monitoring on the Output Monitor board.
c. The blower current monitors K6 through K9 in the Power Supply Compartment.

These faults inputs are summed together on the Transmitter Interface board, sent to the Controller on J6-5, and called Air Flow Reduced-L. Once latched, the fault is called AF.R.X.

The Foldback Controller can not respond to this fault until Enable 2 has been generated by the PWR PAL.

When the AF.R.X input goes low, the Foldback Controller will immediately attenuate the power output -6dB. This is the only amount of reduction possible.

ATTEN	MINIMUM TIME
0dB	
6dB	250 uS

If air flow is still insufficient to properly cool the transmitter at the reduced power level, Air Flow Monitoring circuits on the Modulation Encoder boards and the Output Monitor board can still generate a Air Flow Fault-L (AF.FLT.X) that will turn the transmitter OFF.

Refer to the FGATE 2 PAL for more information.

M.5.6.7 Air Flow Recovery

If the AF.R.X input goes high, the Recovery Controller will immediately step back up to full power.

ATTEN	MINIMUM TIME
0dB	
6dB	250 uS

M.5.6.8 Foldback Output

When Foldback is in progress the Foldback output will go low for the duration of Foldback and illuminate the Analog Input Power Foldback indicator RED on the Control front panel.

This output is latched and the indicator remains RED even if Recovery has stepped the power back up to full output.

M.5.6.9 Foldback Limit

If the maximum amount of Foldback is not enough to protect the transmitter during VSWR and Over Temperature faults, the Foldback Limit output that is sent to the FLT 1 PAL will go high and turn the transmitter OFF.

M.5.6.10 Reset Input

The Fault Reset will clear the Foldback/Recovery Controller. If the offending fault is still present, Foldback will again attenuate the power output. If the fault is no longer present, the transmitter will return to full power.

M.5.6.11 Fault Input

If the Master Reset FLT line from the FLT1 PAL goes high, the Foldback/Recovery Controller is reset and the FLDBK.ERR output will go low.

M.5.6.12 Error Output

If the Foldback/Recovery Controller detects any invalid state or if the FLT input goes high, the FLDBK.ERR (Foldback Error) output will go low. This will illuminate the PAL Fault Indicator DS1 RED.

M.5.7 AC Restart-Overload-OFF Faults - FGATE 2

These faults and manual fault switch inputs are connected to the FGATE 2 (Fault Gate 2) PAL.

They are categorized into either FACR, FOVR, or FOFF type faults and applied to the FLT 1 PAL for processing. They can be measured at TP3, TP2, and TP1 respectively.

Refer to Figure M-6, FGATE 2 PAL.

The FGATE 2 PAL has several logic gates interconnected to accomplish the necessary fault categorization.

M.5.7.1 A/C Restart Faults

The following are FACR faults and their abbreviations.

AC MAINS FAULT	PS.PE.X
CONTROLLER UNREGULATED LOSS	C.UL.X

The PS.PE.X fault can be generated by either by the AC Mains Fault from the 3PH A/C Monitor K10 in the Power Supply Compartment that enters the controller at J6-33 or the Controller Unregulated Loss Detector (PC.UL.ACR) U36-13 (TP19) on the Controller.

M.5.7.2 Overload Faults

The following are FOVR faults and their abbreviations:

RF AMP POWER SUPPLY CURRENT FAULT	PS.OC.X
RF AMP POWER SUPPLY VOLTAGE FAULT	PS.VE.X
DRIVER OVERDRIVE FAULT	DR.OD.X

The PS.VE.X fault is generated by the RF Amp Power Supply Voltage Detector on the Controller.

M.5.7.3 Off Faults

The following are FOFF faults and their abbreviations.

External Interlock	I.EXT.X
Door Interlock	I.DOOR.X
Encoder Supply Fault	E.SF.X
Encoder Cable Interlock	E.CI.X
Overtemperature Fault	OT.OFF.X
Air Flow Fault	AF.FLT.X

WARNING: Disconnect primary power prior to servicing.

M.5.7.4 Fault Enables

During the Step Start Sequence when most transmitter circuits have not yet reached their steady state condition, some fault inputs must be ignored.

Faults that are active all of the time and that the Controller can immediately respond to are:

PS.PE.X

C.UL.X

P.S.OC.X

I.EXT.X

I.DOOR.X

Other faults are responded to only when Enable inputs are present.

M.5.7.5 Enable 1 Input

Faults that are active only when Enable 1 is present are:

E.SF

E.CI

M.5.7.6 Enable 2 Input

Faults that are active only when Enable 2 is present are:

OT.OFF.X

AF.FLT.X

DR.OD.X

P.S.VE.X

M.5.7.7 Manual Fault Switches

The Manual Fault Switches can be used to test the Controller response to these three types of faults.

When the Manual A/C Restart switch S3 is depressed and held down, the transmitter will shut OFF and remain that way. When the switch is released, the transmitter will automatically return to the same power level as before the switch was depressed.

When the Manual Overload Fault switch S4 is depressed and held down, the transmitter will shut off and remain that way. When the switch is released, the transmitter will automatically return to the same power level as before the switch was depressed. If the switch is depressed once more within 5.5 seconds, the transmitter will shut OFF and remain OFF.

When the Manual Fault Off switch S2 is depressed the transmitter will shut OFF and remain OFF even after S2 is released.

M.5.7.8 I.EXT.A and I.DOOR.A Outputs

These outputs are connected to the Fault LED Latching circuits.

M.5.8 Fault Handling - FLT1 and FTIM

The FLT1 (Fault 1) PAL accepts the FOFF, FACR, and FOVR faults from FGATE2 and the Foldback Limit from the FLDBK PAL.

It responds to these faults by controlling the Enable Turn-On Request that is sent to the LR PAL. ENTOR signals the LR PAL that no inhibitive faults are present. Conversely, loss of ENTOR recoverably faults the transmitter OFF.

It is the source of the FLT Master Reset that is connected to most PALs. It will halt all PAL activity and clear them to an off or ready state.

The FTIM (Fault Timing) PAL gives the timing sequence of events for the FLT1 PAL. TAC and TOV are timeout signals for FACR and FOVR recovery respectively. These signals are sent back to the FLT1 PAL to indicate fault timeouts.

Refer to Figure M-8, FLT 1 and FTIM PALs.

M.5.8.1 A/C Restart Handling

FACR triggers an immediate, fully recovering, shutdown of the transmitter by canceling the ENTOR signal.

Loss of ENTOR to the LR PAL cancels the TOR output from LR PAL to the PWR PAL. It does not assert FLT, allowing PALs to retain memory of operation mode. In particular, OPR retains the coarse power level selection.

AC1 and AC0 provide fault status from the A/C Restart Fault Handling in the FLT 1 PAL to the 160mS A/C Restart Timer in the FTIM PAL. The TAC output of this timer is sent back to the FLT 1 PAL.

When the FACR input goes low, the Mute Request output goes low and the AC0 output will go high.

One clock cycle (250 uS) later, the ENTOR output will go low and the AC1 output goes high.

When both AC0 and AC1 outputs are high, the 160mS A/C Restart Timer is started and 160mS later the TAC output will go high for 250 uS. The AC0 output will go back low at the end of the TAC pulse.

If the FACR input is not low at this time, 250 uS later the Mute Request and ENTOR lines will go high and the AC1 output will go low. This will generate a new TOR and the transmitter will return to operation.

If the FACR input is still low at this time, the outputs will remain in this state. When the input does go back high (up to four days with battery backup installed), 250 uS later the Mute Request and ENTOR lines will go high and the AC1 output will go low. This will generate a new TOR and the transmitter will return to operation.

Upon reoccurrence, this fault is not upgraded to an FOFF. An FACR will co-exist with an in progress FOVR, each will recover according to its own timing and requirements.

M.5.8.2 Overload Fault Handling

FOVR triggers an immediate, fully recovering, shutdown of the transmitter by canceling the ENTOR signal.

Loss of ENTOR to the LR PAL cancels the TOR output from LR PAL to the PWR PAL. It does not assert FLT, allowing PALs to retain memory of operation mode. In particular, OPR retains the coarse power level selection.

OV1 and OV0 provide fault status from the Overload Fault Handling in the FLT 1 PAL to the 160mS Overload Restart Timer in the FTIM PAL. The TOV output of this timer is sent back to the FLT 1 PAL.

When the FOVR input goes low, the Mute Request and ENTOR outputs will immediately go low and the AC1 output goes high.

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The outputs will remain in this state, until the FOVR input goes back high. When the input does go back high, the OV1 output will go high.

When both OV0 and OV1 outputs are high, the 160mS Overload Restart Timer is started and 160mS later the TOV output will go high for 250 uS.

The OV0 and OV1 outputs will go back low, and the Mute Request and ENTOR lines will go high. This will generate a new TOR and the transmitter will return to operation.

After 5.6 seconds, a high UNFLT pulse from the PTIM PAL is sent to the FLT 1 PAL.

If another FOVR fault occurs within this time, the FLT 1 PAL will upgrade it to an FOFF Fault.

If another FOVR fault occurs after this time, the FLT 1 PAL will respond to it as another FOVR Fault.

An FOVR will co-exist with an in progress FACR, each will recover according to its own timing and requirements.

M.5.8.3 Other Overload Faults

There are two types of special Overload Faults.

DRIVER UNDERDRIVE FAULT (LOW DRIVE)	DR.UD.X
RELAY K2 FAULT	K2OV

The DR.UD.X input at J6-13 will occur anytime RF Drive to the Big Step and Binary RF Amplifiers is reduced to less than 80% of normal. If the offending fault was created in the RF Chain, the Control front panel should indicate the location.

The K2OV Fault from the PWR PAL input announces main contactor dropout at inappropriate times, and is designed to protect the step-start system. There is no status indication for this fault.

Both are recognized after ENBL2 is generated by the PWR PAL.

If either fault input goes low, the ENTOR output is removed and then returned 160mS after a TOV pulse.

If the fault is still present after Enable 2 is generated on the retry, the FLT 1 PAL will upgrade it to an FOFF Fault.

M.5.8.4 OFF Fault Handling

Fault OFF triggers an immediate, non-recovering, shutdown of the transmitter by generating a Mute Request and canceling the ENTOR signal.

The OFF Fault Handling asserts the FLT line to asynchronously clear all PAL state machines.

The transmitter must be manually restarted after the fault has been corrected.

An FOFF will override an in progress FOVR or FACR.

M.5.8.5 Foldback Limit

The FBLIM input from the FLDBK PAL indicates maximum Foldback has been reached.

When this input goes high, it becomes an FOFF Fault.

M.5.8.6 LED Enable

The LEDEN output controls enabling of the Fault LED Latching circuits and therefore the Control front panel indicator LEDs.

KLVX Supply Low Voltage Sensing and C.UL Controller Unregulated Loss provide status of low voltage supplies. Both must be high for these indicators to be illuminated.

Should either input go low, the LEDEN output will go high and the indicators are turned off to conserve battery backup voltage.

M.5.9 PAL Fault Indicators

Bicolor indicators DS1, DS2, DS3, and DS4 are controlled by U14 and provide a visual status indication for their designated PALs.

When the LEDINH (LED Inhibit) output from U36-2 is low, the indicators are active.

GREEN illumination indicates normal operation, RED illumination indicates a internal fault condition.

Refer to each individual PAL for the more specific information.

When a Controller Unregulated Loss is detected, The LED Inhibit line will be high and the indicators are turned off to conserve battery backup voltage.

M.5.10 Clock Generator

The 8 kHz master clock is generated by a 555 timer U20 running in an astable configuration. This clock is divided down by a string of synchronous dividers U15 through U19. Six different clock frequencies are generated and distributed, most of which can be measured on TP4 though TP8.

M.5.11 LATCH PALs

Most of the faults to which the Controller has responded, except the RF MUTE and VSWR Test, are latched by the three LATCH PALs U11, U12, and U13.

Refer to Figure M-9, LATCH PAL.

Each of the three LATCH PALs has exactly the same internal circuits. They contain 10 fault inputs, 10 latches, and 10 alarm outputs.

After the Enable input is high, if the fault input to the PAL is or goes low, the Alarm output will go low and remain in that state until the Reset input goes high.

U12 is connected to Enable 1, U11 is connected to Enable 2, and U13 is connected to Enable 3, and the Reset is connected to pin 13. LATCH PAL alarm outputs are connected to the Fault LED Latching inputs.

M.5.12 Other Latches

U26 and U33 function in a manner similar to the LATCH PALs, except that they use diode steering logic to accomplish this task and are always enabled by FCLK0.

When the input of U26 goes low, the output of U33 goes low. The input of U26 is then held low to +.6VDC by the diode drop, and the output of U33 remains low.

It is not possible for the output of U33 to go back high until the Reset input is high.

WARNING: Disconnect primary power prior to servicing.

The I.EXT.A input from FGATE 2 PAL can be jumpered P50 2-3 for a latched fault or 2-1 for a unlatched fault. This is the only fault in the transmitter that is programmable.

M.5.13 Fault LED Latching

Outputs from the Fault LED Latching circuits are connected to the LED board on the odd numbered pins of J2 and J12.

Octal buffers U30 through U32, and U34 will allow lighting of the indicators on the Control front panel when the LEDEN input is low.

When the LED Enable input from the FTIM PAL is high, all outputs assume a high impedance off state and therefore disables the LED board indicators.

M.5.14 Summary Faults and Remote Fault Indicator Outputs

Summary Fault outputs are sent to the External Interface board on J5-13 through J5-31 for extended/remote indicators.

Table M-1 lists the Summary Faults and their causes.

M.5.15 Power Supplies

M.5.15.1 Input Power Distribution

A power distribution cable from the Transmitter Interface board is connected to J11 on the Controller. J9 and J10 connect the low voltage supplies to the Analog Input and A/D Converter boards.

When P53 is in the Normal position, the +12VDC Controller Supply is connected to the LED & Switch boards and to the Controller Power Supplies. The transmitter can be operated in the Standby Mode.

If P53 is in the Bypass position, the B+ power supply is used to power these boards and the transmitter must be in the STANDBY Mode for operation.

M.5.15.2 Controller +5VDC Supply

Two regulators U51 and U52 are diode OR-ed together by CR141 and CR140 and supply +5VDC for all logic circuits on the Controller board.

Respectively, the regulators are separately fused by F4 and F3, offset to provide +5.6 VDC output (to overcome the OR'ing diode drops) by diodes CR148 and CR144, and indicators DS6 and DS5 provide a GREEN visual indication of operation.

The output voltage can be measured at TP16, and is connected to the Analog Input board at J1-33 where is called the +5VC supply.

If either regulator fails, the Controller can operate normally from the other regulator.

M.5.15.3 1.2VDC Reference

A dropping resistor R44 and zener diode regulator CR138 form a 1.2VDC reference supply. This voltage is connected to six comparators that use this reference as a indication of the +5VDC supply.

M.5.15.4 Controller Supply Fault Voltage Detector

Should either +5 VDC regulator fail, diodes CR130 or CR129 will be forward biased and establish +.6VDC at the + input of U36-9. The output will go low and Controller Supply Fault is generated. It can be measured at TP17 Supply Fault and provides a visual indication on the Control front panel only.

M.5.15.5 Backup Capacitor

The backup supply uses two one farad capacitors, C46 and C47. They are initially charged from the +5 Volt supply, through diodes CR140 and CR141.

If there is a loss of Single Phase A/C power, diodes CR140 and CR141 will be reverse biased so that the backup capacitors discharge only into the circuits on the Controller and Analog Input boards.

The capacitors alone can maintain PAL memory at least 10 minutes or until the voltage at TP16 reaches 4.5 VDC.

M.5.15.6 Battery Backup Detector And Battery Backup Switch

When the voltage at TP16 lowers to 4.5 VDC, the voltage at the - input of U37-7 will equal the 1.2 VDC Reference Voltage.

Comparator U37-1 will go low and turn on Q3 which connects the +5VDC Controller Supply to the +6VDC Battery Supply (assuming it is installed) through diodes CR131 and CR132.

The Battery IN voltage at J11-12 should maintain PAL memory for at least four days.

M.5.15.7 Transmitter Interface +5VDC Supply

A third regulator U53 supplies +5 Volts for the Transmitter Interface board. It is fused by F2 and connected to J7-23.

M.5.16 Controller Monitoring

NOTE

The following Controller Monitoring circuits use the 1.2 VDC Reference Voltage as an input to their fault detection process.

M.5.16.1 Controller Unregulated Loss

If the Single Phase A/C Mains fails, the Unregulated Supply Loss Detector will create a Controller Unregulated Loss Fault.

A resistive voltage divider normally establishes 1.3VDC at the + input of U36-11. When the Controller Supply begins to discharge due to a power failure, this voltage becomes less than the 1.2VDC reference and the output of the comparator U36-19 will go low.

This is an A/C Restart Fault that can be measured at TP19 and is distributed to four other circuits.

a. The C.UL.ACR output is summed together with the 3 Phase A/C Mains Fault at J6-33 and latches as a PS.PE.

b. The output to the LED board at J2-3 will disable the Local and Remote LEDs on the Control front panel.

c. The C.UL output will disable the LED Enable from the FTIM PAL and becomes a latched C.UL.X that is sent to the FGATE 2 PAL.

d. The output that is connected to the -input of U36-4 will generate a LED Inhibit.

When TP19 returns high after the power has been restored, the A/C Restart Handling in the FLT1 PAL will restart the transmitter.

WARNING: Disconnect primary power prior to servicing.

M.5.16.2 LED Inhibit

When the C.UL input at U36-4 goes low, the LED INH output of U36-2 will go high. The LED Inhibit will disable the PAL Fault Indicators.

M.5.16.3 Reset

The Reset output will clear any latched faults contained by the LATCH PALs and will also clear any Foldback in progress.

Each of the following will produce the Reset used by the Controller because the - input of U37-8 will be pulled low and therefore the output at U37-14 will go high:

a. A Remote Reset-L input at J5-39 that turns on Q2.
b. The Control front panel Fault Reset switch is depressed causing a low at J2-5.
c. The onboard Reset switch S6 is depressed.

M.5.16.4 Low Voltage Supply Sensing

When the +8VDC supply is operational, a resistive voltage divider will establish 1.6VDC reference at the + input at U36-7, U36-1 will generate a high KLVX signal that tells the PWR PAL the low voltage power supplies are active. When the supply is off the Output of U36-1 will be low.

M.5.17 Other Controller Monitoring

M.5.17.1 RF AMP Power Supply Voltage Detector

A voltage sample of the +230VDC RF Amp Power Supply that is derived from the Supply Voltage Fault Sample on the A39 Fuse Board is connected to J6-15.

An Overvoltage Comparitor U37-2 and an Undervoltage Comparitor U37-13 can create a Power Supply Voltage Error if the +230VDC rises over 268VDC or falls under 115VDC. The PS.VE is treated as an Overload Fault.

Under normal +230VDC conditions, the input voltage to U37-4 and 11 is 3.0VDC, and a resistive voltage divider establishes 1.5VDC at U37-10 and 3.5VDC at U37-5.

M.5.17.2 Remote Control Interface

When P52 is jumpered 5-6, the Remote Control output voltage to the External Interface at J5-9 is determined by the Remote Control switch in the Control front panel. When in the Remote position, Remote Control line is high and active. When in the Local position, Remote Control line is low and inactive.

If P52 is jumpered 3-4, Remote Control is always active.

If P52 is jumpered 1-2, Remote Control is always inactive.

M.5.18 Turn-On Sequence

The transmitter turn-on control logic, turns the transmitter on in stages or steps, and provides logic outputs to other parts of the transmitter during the turn-on sequence. If an error occurs during the turn-on sequence, turn-on will be aborted immediately.

The following procedure assumes that the transmitter is normal and has not incurred any faults that affect the normal turn-on sequence.

The sequence of events when the transmitter is turned-on at HIGH power while in the Standby Mode is as follows:

NOTE

Up until the point that Enable 3 goes high, FGATE1 will be generating an RF Mute to hold the Big Step and Binary RF Amplifiers off during the turn-on sequence.

a. When the HIGH power pushbutton switch on the Switch Board is depressed +12VDC is applied to the Controller at J3-32.
   1. This active high input turns on the transistor inside U40, causing pin 8 to low.
b. This logic low is applied to the Operator PAL U5-3 (High In).
   1. U5-23 (High) goes high and is sent to LR PAL U6-3 (High) to generate a TOR (Turn-On Request).
   2. U5-23 also turns on transistor U42-8 which pulls TP10 low. When TP10 is low:
      a) J3-27 illuminates the lamp inside the High power pushbutton switch.
      b) J5-3 activates the Remote Status Output on the External Interface.
   3. U5-15 (Keypress) which connects to the LR PAL U6-10 goes high as long as any button is pressed and inhibits any Raise or Lower command input.

Table M-1. Summary Faults and Their Causes

Output	Caused By
Summary Fault Output	Any fault in the transmitter, it is diode OR'ed together with all outputs.
Foldback	Anytime the Controller initiates Foldback.
RF Drive Chain Fault	DR.UD.Q, BR.RF.Q, OSC.RF.Q, DR.OD.Q, PR.RF.Q.
RF Amp Fault	FUSES.Q, OT.RFA.Q.
VSWR Fault	VST.STAT.X, OM.AV.Q, OM.ON.Q.
Power Supply Fault	PS.OC.Q, PS.VE.Q, OT.PS.Q.
A/C Mains Fault	PS.PE.Q.
Air Flow Fault	AF.FLT.Q, AF.R.Q
Low Voltage Supply Fault	C.SF.Q, E.SF.Q, AI.SF.Q, OM.SF.Q, AD.CE.Q, AD.SF.Q.
Interlock Open I.	DOOR.Q, I.EXT.Q, E.CI.Q.

WARNING: Disconnect primary power prior to servicing.

c. The high input at the LR PAL U6-3 (High) will generate a high Turn-On Request at U6-21 (TOR) as long as U6-13 (ENTOR)is high.
   1. The ENTOR (Enable Turn-On Request) comes from the FLT1 PAL U3-21. It must be high for the LR PAL to generate a TOR.
   2. The VSWR Test output at U6-18 will go high for 8mS, this turns on Q1 and J7-9 VSWR Self Test Request goes low. This low signal is sent to the Output Monitor for testing the VSWR detectors.

d. Refer to Figure M-10, Step-Start Timing Diagram for the following discussion.

e. The TOR from U6-21 is applied to the PWR PAL U7-11 and the PTIM PAL U8-10.
   1. The high TOR input to U8-10 generates a high output pulse at U8-20 1.5 seconds later. This output is sent to U7-13 and is the signal that tells the PWR PAL to go to the Ready State.

f. 32 ms later, on the second Time pulse, the output of U7-20 (KLV) will go high.
   1. This signal turns on the transistor inside U43-8 and J14-19 goes low. The solid state relay K5 closes and single phase AC is applied to the low voltage power supply(s) and they begin to charge up.
   2. The high signal is also sent back to U8-6 to tell the PTIM PAL that K5 has closed.
   3. When the +8 VDC supply is charged up, the output of the Supply Voltage Sensing comparator U36-1 (KLVX) will go high and this signal is sent back to U7-3.

g. On the third Time pulse, 32ms later, the output of U7-16 (MODENC) will go high.
   1. This signal is connected to J14-20 and a TX ON ENABLE-H is sent to the Transmitter Interface. The TX ON ENABLE will:
      a) Turn on the B+ and B- regulators, activate the fault sensing, and supply the voltage for the fuse fault detector on all of the Modulation Encoders.
      b) Turn on the Predriver and applicable Drivers, delay the Auto Driver Control for 1.5 Seconds, and delay the Low Drive Fault sensing on the Driver Encoder.
      c) Activate the Air Flow Monitor A3 in Output Cabinet via the control on the Output Monitor.

h. 32 ms later, on the fourth Time pulse, the output on U7-19 (Enable 1) will go high.
   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FGATE2 in addition to clocking the Latch PAL U-12.
   2. The high signal is also sent back to U8-7 to tell the PTIM PAL that Enable 1 is activated.

i. Also on the fourth Time Pulse, the output of U7-22 (K1) will go high.
   1. This signal will turn on the transistor U43-7 and J14-18 goes low. The step start solid state relay K3 closes and single phase AC is applied to the Step Start contactor K1. When K1 closes, 3 Phase AC mains are applied to the RF AMP Power Supplies through the step start resistors R1, R2 and R3. The supplies begin to charge up through these current limiting resistors.
      a) This signal remains high for 1.7 Seconds.
      b) The high signal is also sent back to U8-4 to tell the PTIM PAL that K1 is activated.
      c) An auxiliary contact on K1 sends a high signal from the +22VDC supply to J6-37 Step Start Status-H. This signal is latched by U22-9 and K1X.X is sent to U7-4.

j. On the sixth Time pulse, the output on U7-18 (Enable 2) will go high.
   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1, FGATE2, FLT1, and the FLDBK PALs in addition to clocking the Latch PAL U-11.
   2. The high signal is also sent back to U8-8 to tell the PTIM PAL that Enable 2 is activated.

k. Also on the sixth Time pulse, the output of U7-23 (K2) will go high.
   1. This signal will turn on the transistor U43-1 and J14-17 goes low. The run solid state relay K4 closes and single phase AC is applied to the Run contactor K2. When K2 closes, 3 Phase AC is applied directly to the RF AMP Power Supplies.
   2. The high signal is also sent back to U8-4 to tell the PTIM PAL that K1 is activated.
   3. An auxiliary contact on K2 sends a high signal from the +22VDC supply to J6-39 Run Status-H. This signal is latched by U22-12 and K2X.X is sent to U7-5.

l. 128 ms later on the seventh time pulse, a 128 ms delay timer is started.

m. 128 ms later on the eighth time pulse a 64 ms delay timer is started.

n. 64 ms later the Time pulse, the output on U7-17 (Enable 3), will go high.
   1. This signal is used by the Controller to activate some fault inputs connected to FGATE1 and FLT1 in addition to clocking the Latch PAL U-13.
   2. Up until the point that Enable 3 goes high, FGATE1 has been generating an RF Mute low on U9-20 to hold the Big Step and Binary RF Amplifiers off during the turn-on sequence. When U9-9 goes high, U9-22 goes high and the RF Mute is removed. The transmitter power output goes up to the one quarter of the selected power level and then steps to full power via the Power Ramp circuit on the Analog Input board.

o. Two seconds later and repeated every two seconds afterwards an Unfault pulse is generated for the FLT1 PAL.

This completes the Turn On Sequence.

WARNING: Disconnect primary power prior to servicing.

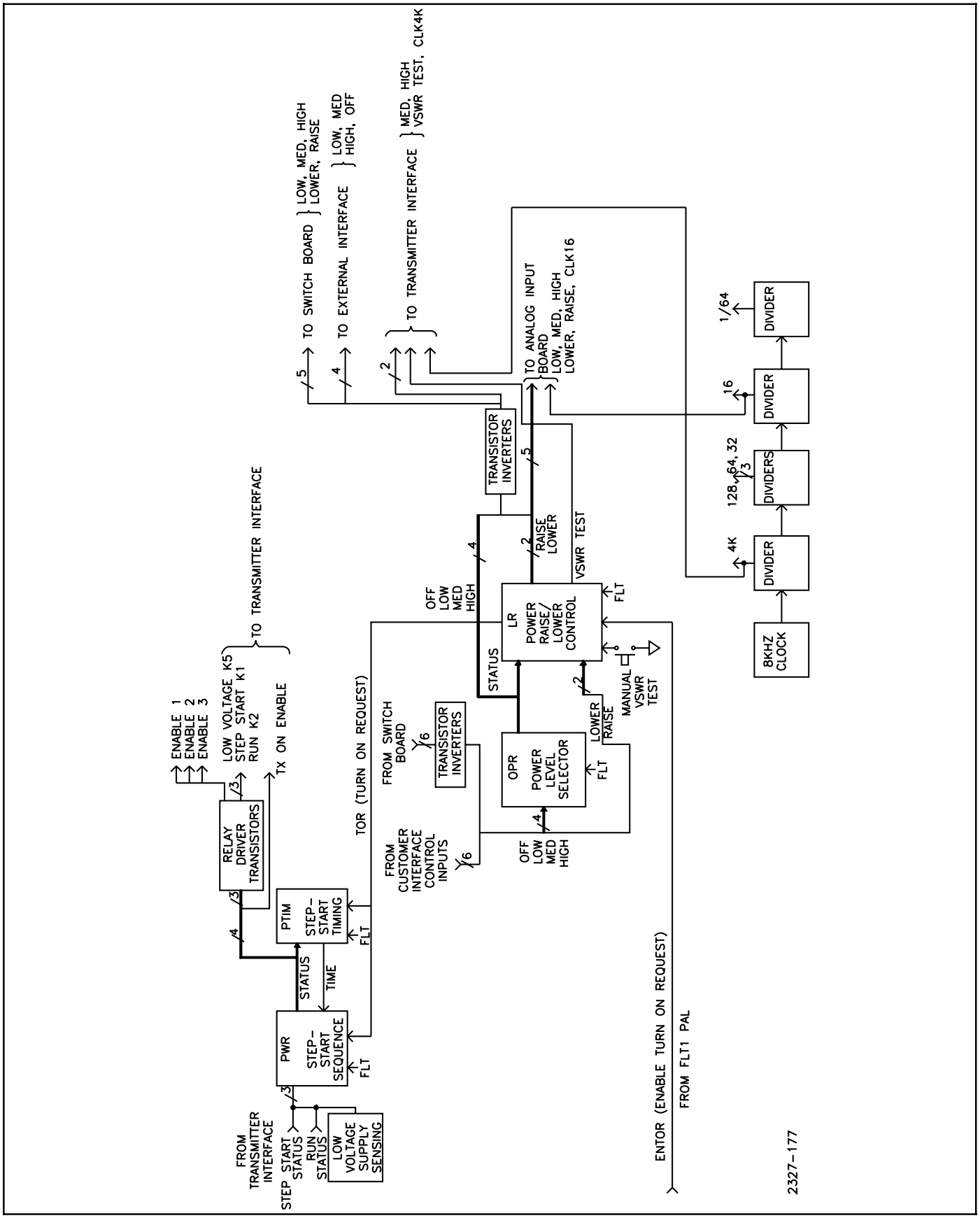

Figure M-1. Power Control Block Diagram

WARNING: Disconnect primary power prior to servicing.

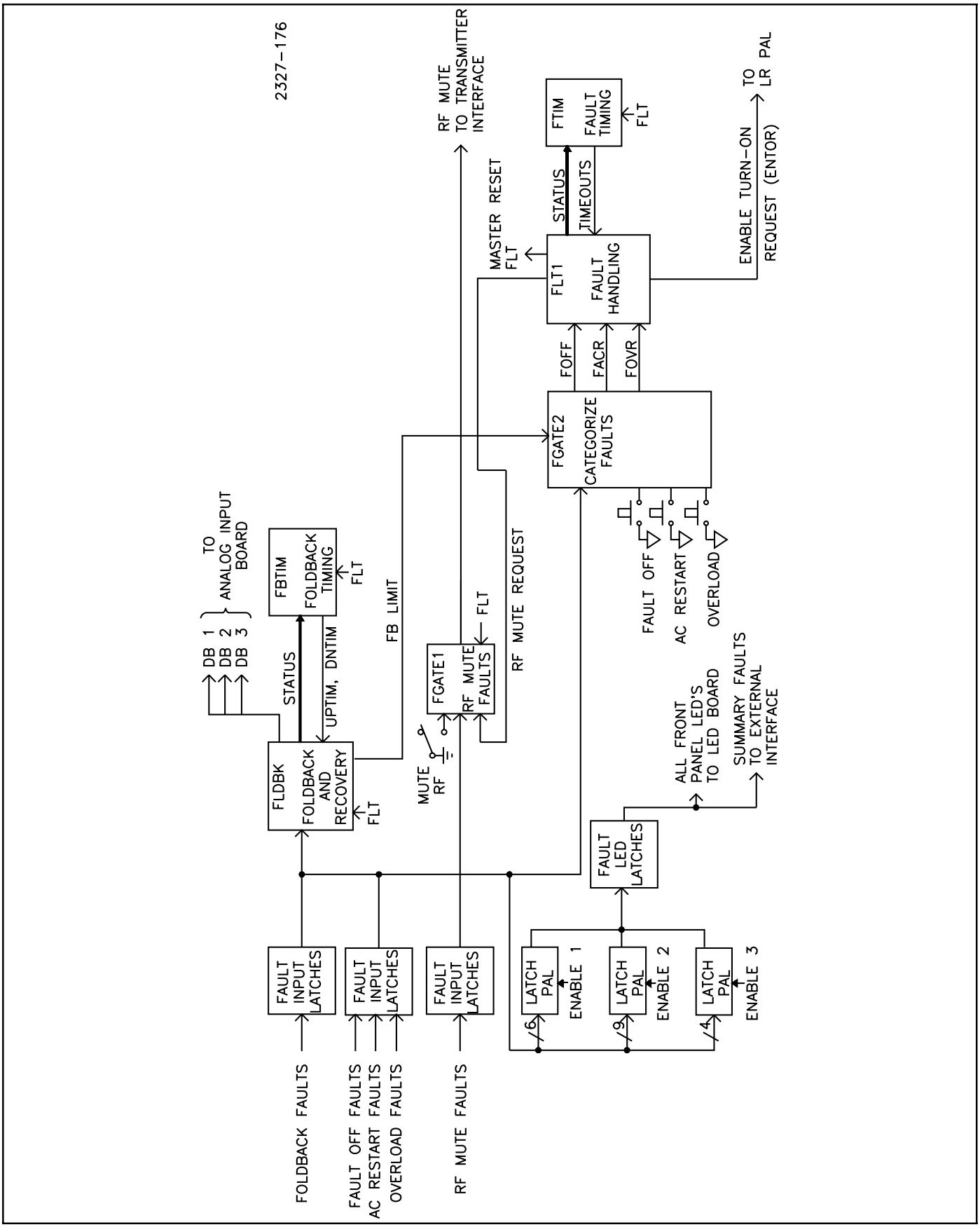

Figure M-2. Fault Handling Block Diagram

WARNING: Disconnect primary power prior to servicing.

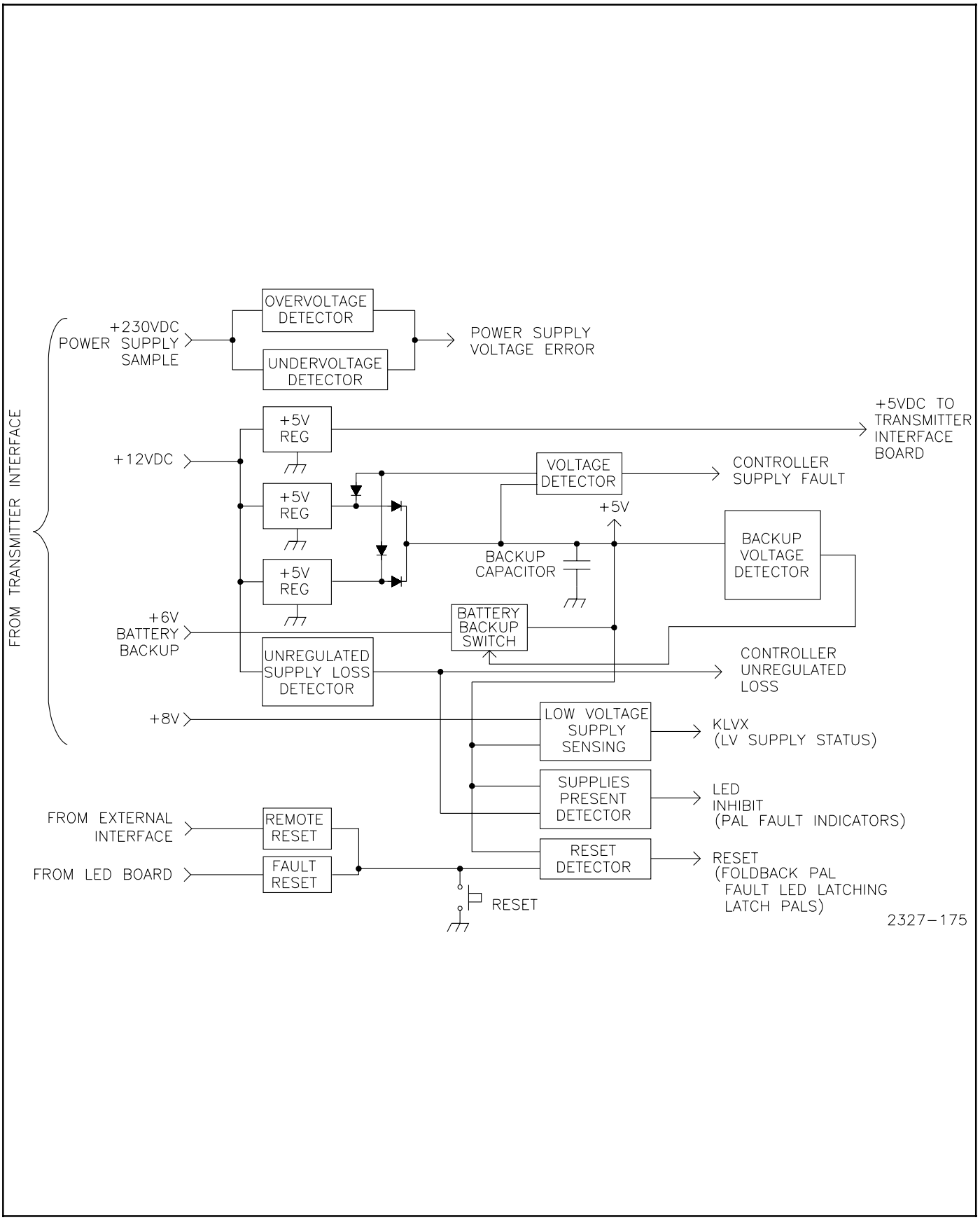

Figure M-3. Power Supplies and Monitoring

WARNING: Disconnect primary power prior to servicing.

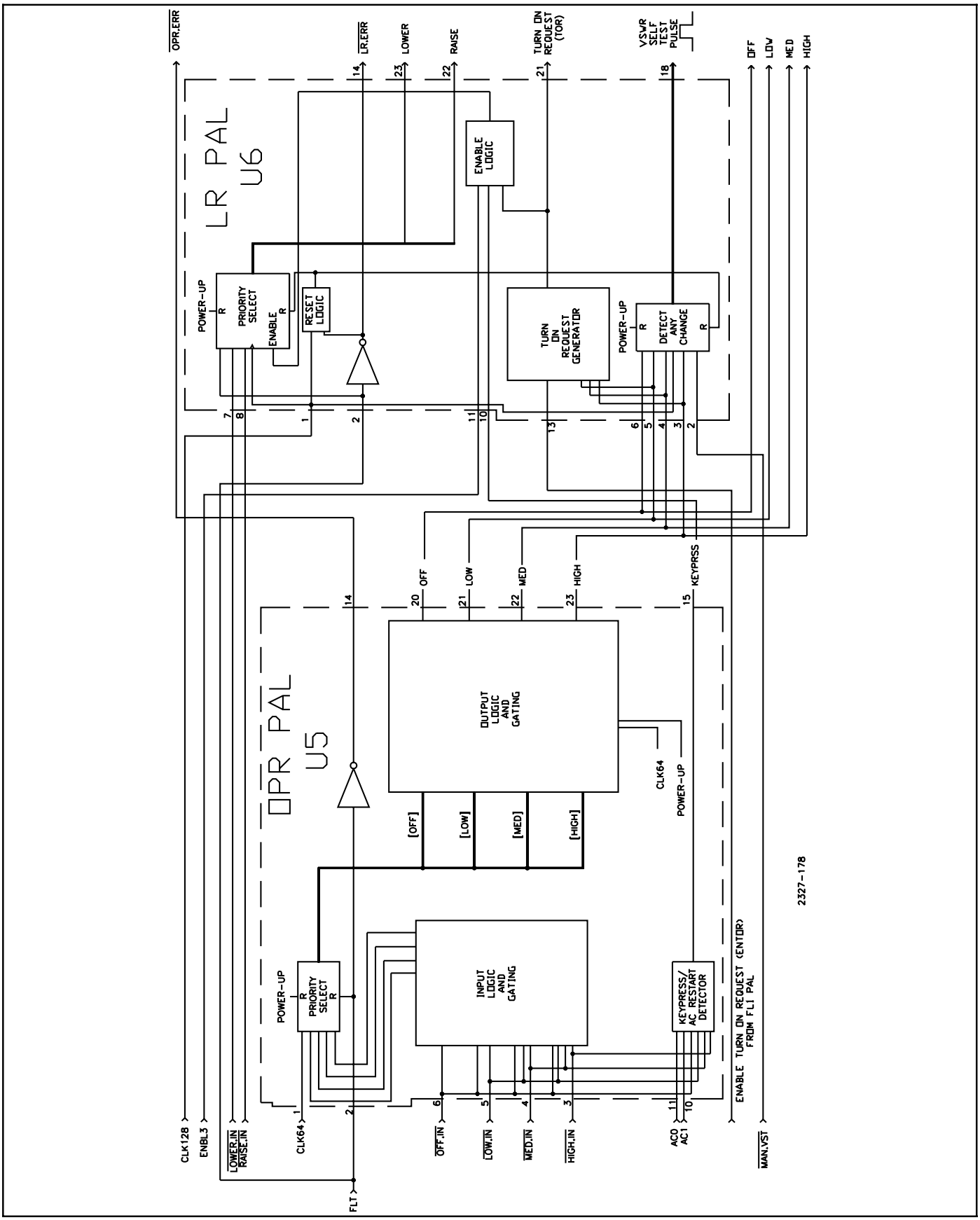

Figure M-4. LR and OPR PALs

WARNING: Disconnect primary power prior to servicing.

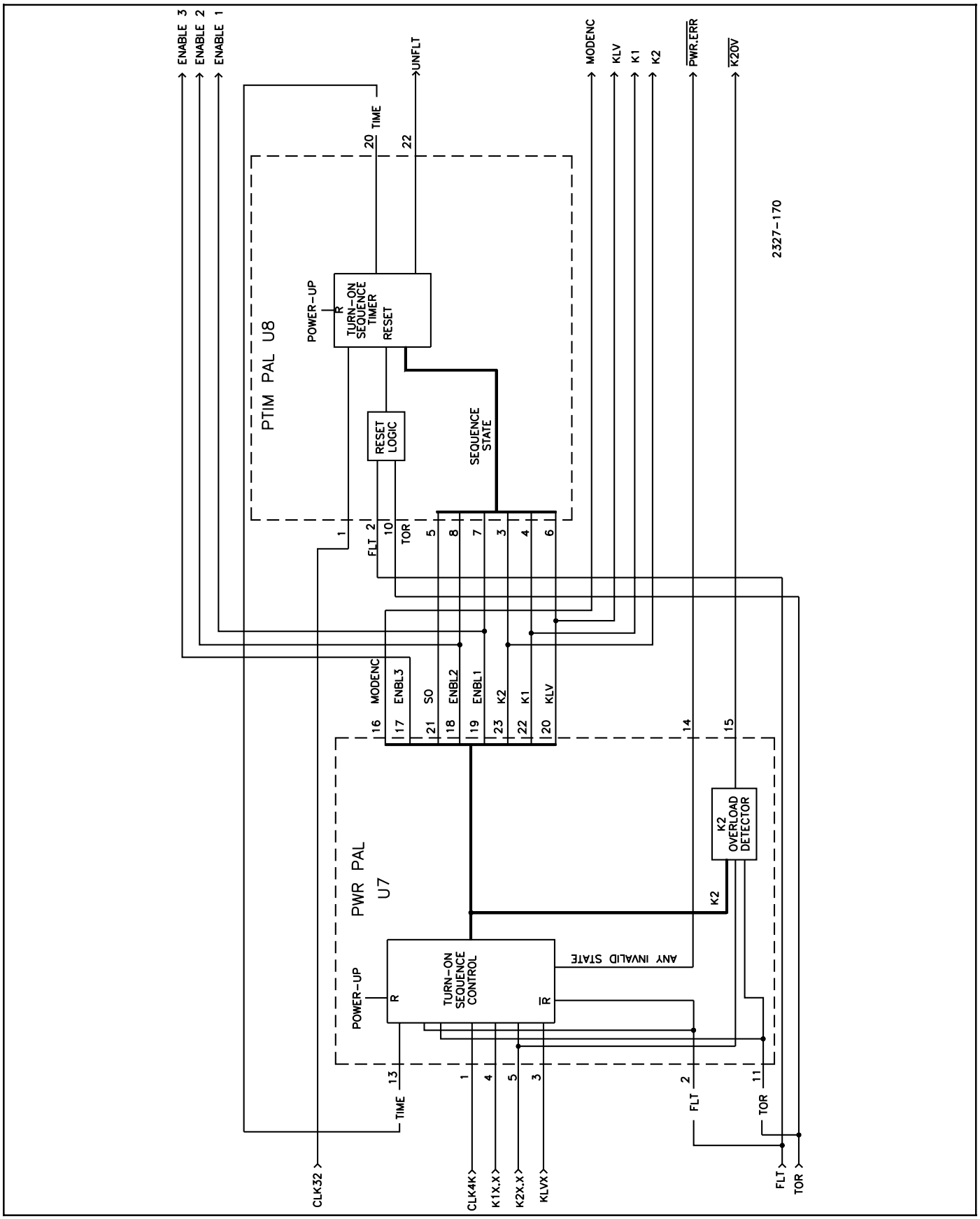

Figure M-5. PWR and PTIM PALs

WARNING: Disconnect primary power prior to servicing.

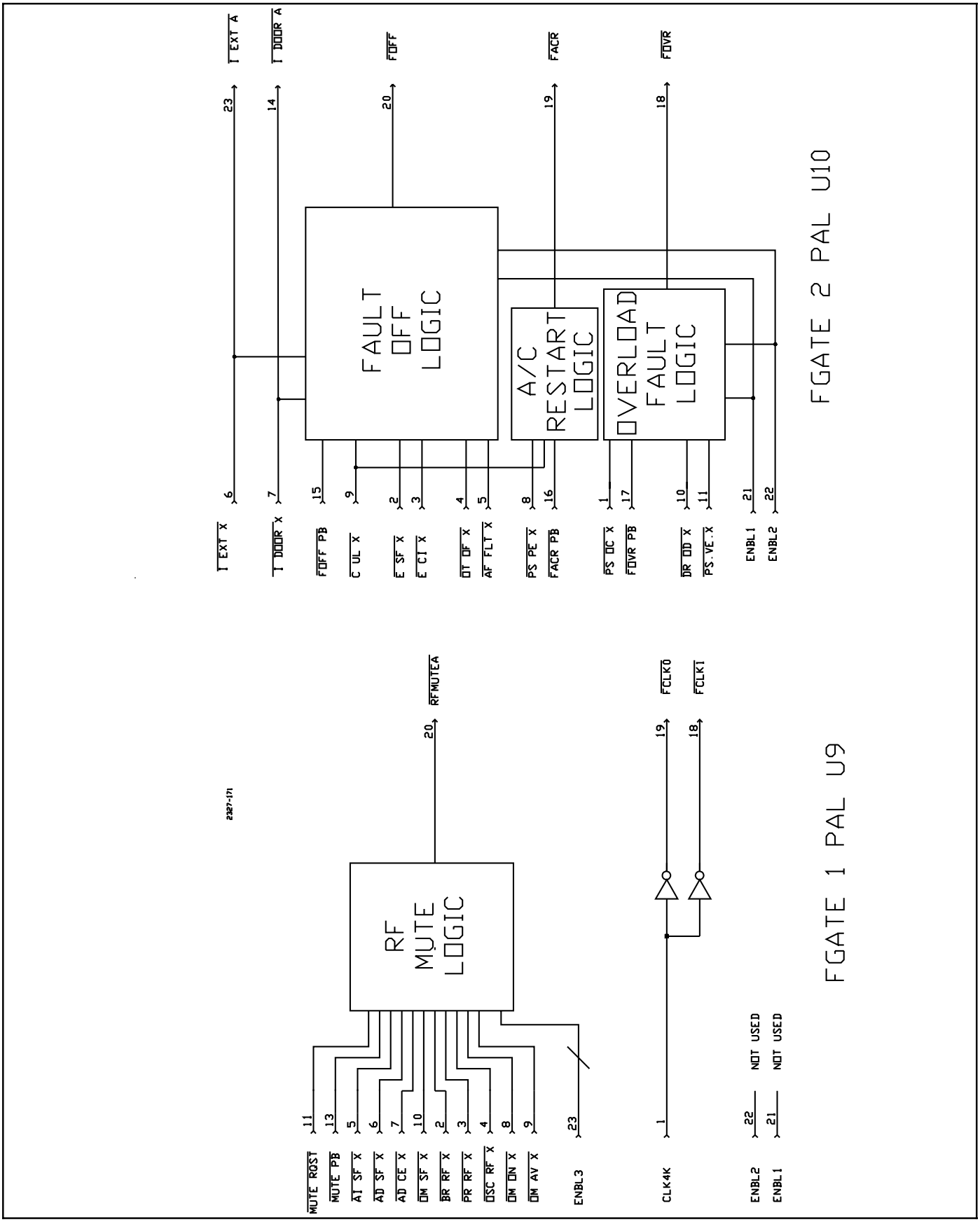

Figure M-6. FGATE 1 and FGATE 2 PALs

WARNING: Disconnect primary power prior to servicing.

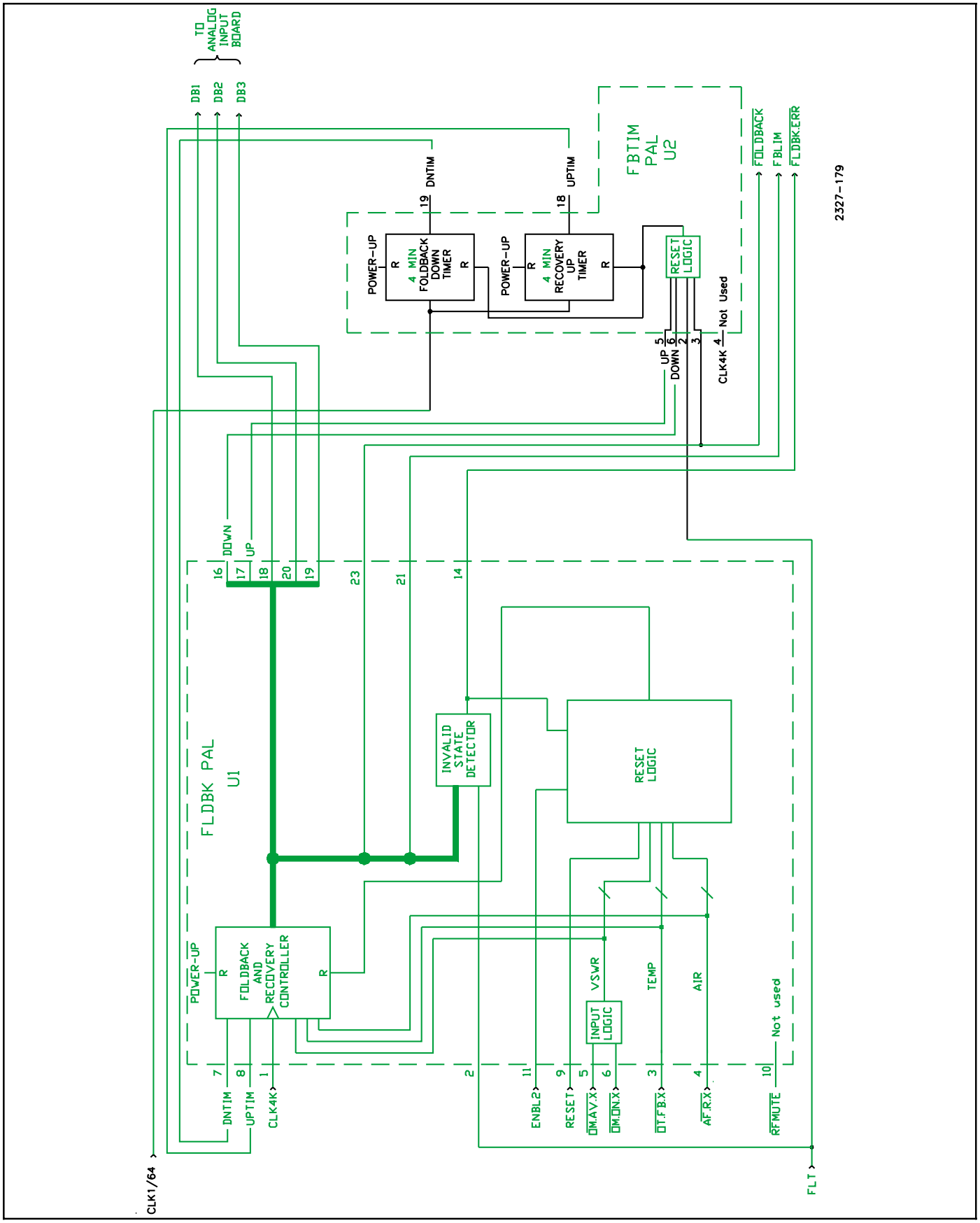

Figure M-7. FLDBK and FBTIM PALs

WARNING: Disconnect primary power prior to servicing.

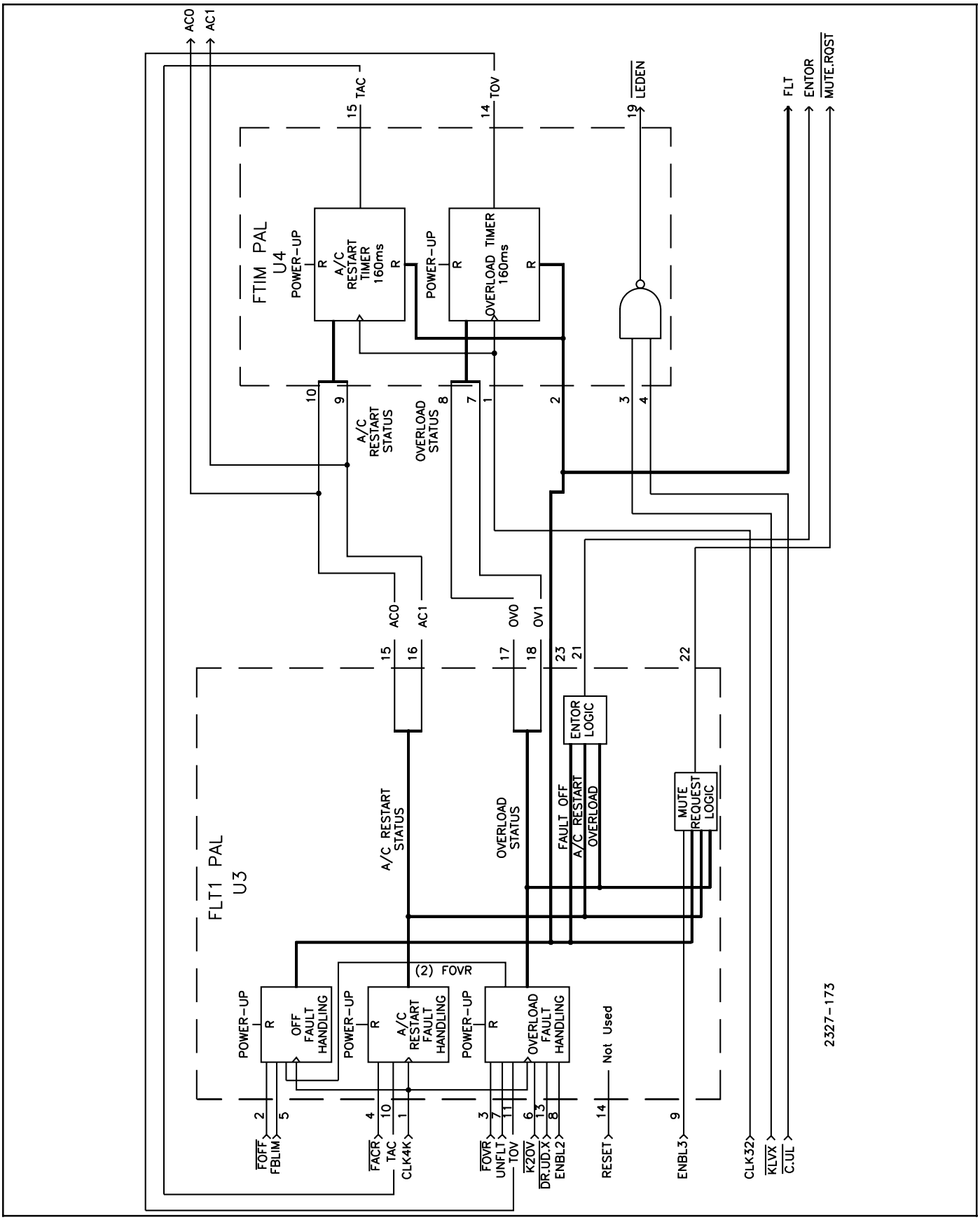

Figure M-8. FLT 1 and FTIM PALs

WARNING: Disconnect primary power prior to servicing.

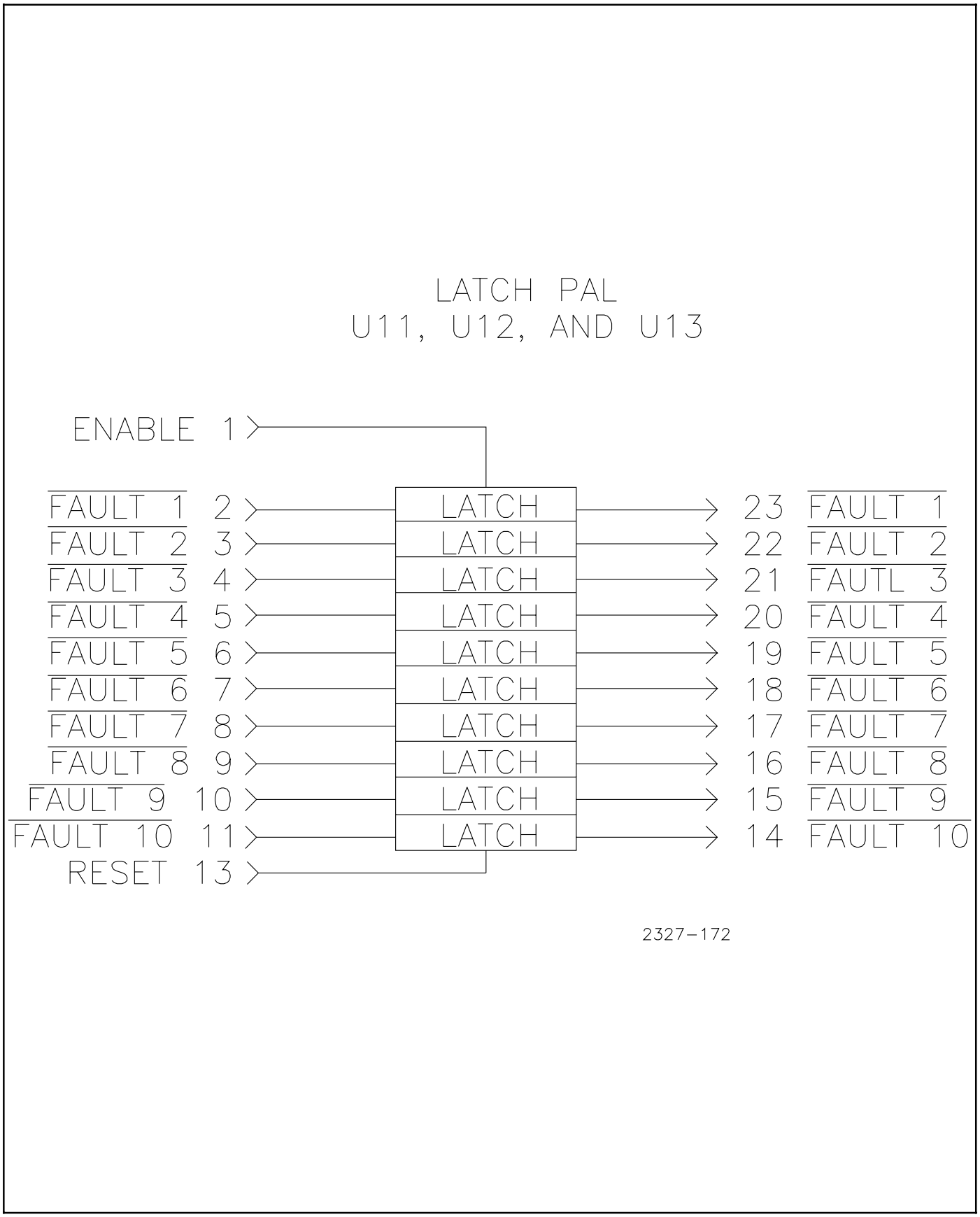

Figure M-9. LATCH PAL

WARNING: Disconnect primary power prior to servicing.

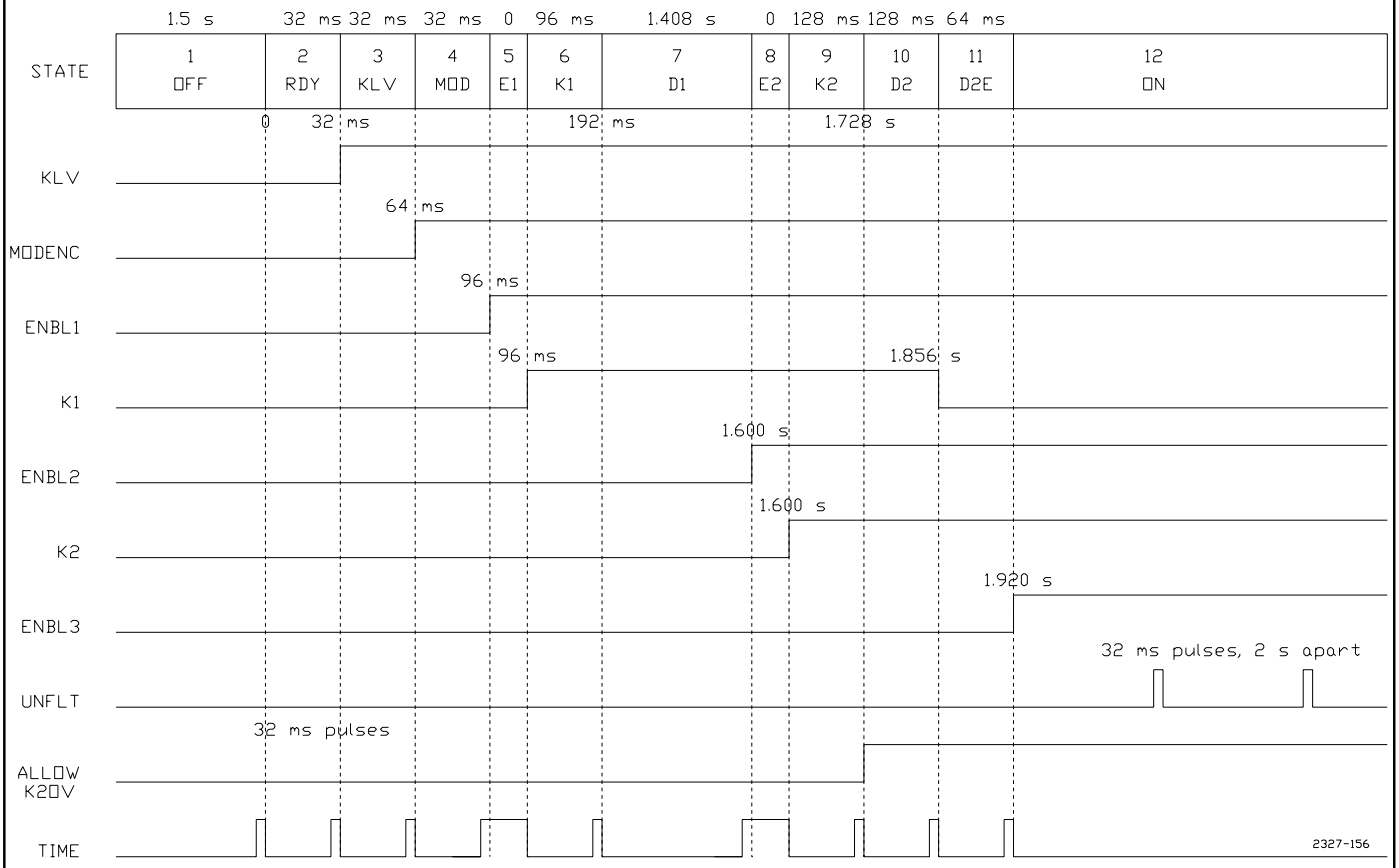

Figure M-10. Step-Start Sequence Timing Diagram

WARNING: Disconnect primary power prior to servicing.

Table M-2. Fault Abbreviation Chart

RF MUTE Faults	
OSCILLATOR FAULT	OSC.RF.X
BUFFER AMP FAULT	BR.RF.X
PREDRIVER FAULT	PR.RF.X
OUTPUT MONITOR NETWORK VSWR	OM.ON.X
OUTPUT MONITOR ANTENNA VSWR	OM.AV.X
OUTPUT MONITOR SUPPLY FAULT	OM.SF.X
ANALOG INPUT SUPPLY FAULT	AI.SF.X
A/D SUPPLY FAULT	AD.SF.X
A/D CONVERSION ERROR	AD.CE.X
Foldback Faults	
NETWORK VSWR	OM.ON.X
ANTENNA VSWR	OM.AV.X
AIR FLOW REDUCED	AF.R.X
OVERTEMP FOLDBACK	OT.FB.X
A/C Restart Faults	
AC MAINS FAULT	PS.PE.X
CONTROLLER UNREGULATED LOSS	C.UL.X
Overload Faults	
RF AMP POWER SUPPLY CURRENT FAULT	PS.OC.X
RF AMP POWER SUPPLY VOLTAGE FAULT	PS.VE.X
DRIVE HIGH FAULT	DR.OD.X
DRIVE LOW FAULT	DR.UD.X
Off Faults	
EXTERNAL INTERLOCK	I.EXT.X
DOOR INTERLOCK	I.DOOR.X
ENCODER SUPPLY FAULT	E.SF.X
ENCODER CABLE INTERLOCK	E.CI.X
OVERTEMPERATURE FAULT	OT.OFF.X
AIR FLOW FAULT	AF.FLT.X

M.6 Troubleshooting

NOTE

Before troubleshooting the Controller it is suggested that the back up batteries be removed from the Transmitter Interface. Before removing any components from the board, it is also suggested that the Capacitor backup be discharged by grounding TP16. Failure to do so could result in short battery life and failure of components.

Due to the nature of PAL operation this troubleshooting procedure is grouped by symptom of problem and then list some steps that will help in determining which PAL or pair of PALs may be defective. Refer to the Controller Schematic (839-7930-021) as needed.

M.6.1 LED Observation

The first step in troubleshooting a Controller problem is to put CB3 on the Power Supply Status Panel in the STANDBY position and observe the LEDs on the board.

a. DS5 and DS6 should be illuminated GREEN indicating both +5VDC power supplies are active.
b. DS1 through DS4 should be illuminated GREEN indicating that there are no faults inhibiting turn-on and all four PALs are operational.

M.6.1.1 Troubleshooting The Power Supplies

There are duplicate +5VDC power supplies on this board, if either supply is not present a Controller Supply Fault will be visible on the Control front panel. A non-illuminated DS5 or DS6 means that supply is faulty, begin by checking the fuse for

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that supply. If open, check the input capacitors and the regulator before replacing the fuse.

If both indicators are illuminated the fault sensing circuitry has failed. Suspect U36 and associated components to locate the fault.

M.6.1.2 All PAL Fault Indicators Are Illuminated RED

This symptom could be caused by either an External or Door Interlock. In either case, the transmitter can not be turned on.

Begin by measuring the fault input on the appropriate Fault Input Latch. If the input is high, no real fault present, sequentially replace the latch, FGATE2, and FLT1 PAL as required.

M.6.1.3 One Or More PAL Fault Indicators Are Illuminated RED

If one or more of the PAL Fault Indicators is illuminated RED, replace the PAL associated with the LED.

M.6.2 Turn-On Sequence Incorrect.

Use the information in the Turn-On Sequence procedure, described above, to aid in troubleshooting. The following information assumes that the problem exists on the Controller and is not a fault input that is aborting the sequence and the most likely cause of any problem would be a defective PAL.

NOTE

Place CB3 on the Power Supply Status Panel in the STANDBY Mode, to activate the low voltage power supplies.

M.6.2.1 LR And OPR PALs

Problems with these PALs would be indicated by no turn-on sequence action, no Lower/Raise control, or no VSWR Self Test function.

a. Check for a logic low input to the OPR PAL when a Power Level pushbutton switch is depressed. If the low is not present, suspect U40 or a loss of signal from the pushbutton.
b. If the input is low, check the input to U6 for a logic high. If not present check for a clock signal on pin 1 of U5. If there is no clock pulse, troubleshoot the clock generator. If the clock pulse is present replace U5.
c. If U6 input is a logic high, check U6-13 (ENTOR) for a high.
    1. If ENTOR is low refer to troubleshooting faulty PALs in this section.
    2. If ENTOR is high, check U6-21 for a high (TOR). If this is not present, check for a clock pulse on U6-1. If not present troubleshoot clock generator. If clock pulse is present and U6-13 is high, replace U6.
d. If TOR is high, check the Local/Remote Transmitter Status Output Test Point for a logic low. If not present suspect U42 or U6.
e. If the Raise/Lower control is not functional, check the inputs to the LR PAL.
    1. If no inputs, suspect U40, U41, and associated components.
    2. If the inputs are correct, check outputs of the PAL. If no outputs, replace U6.
    3. If the outputs are correct, suspect U41 and associated components.
f. If the VSWR Self Test function is incorrect, depress S5 on the board and observe U6-18.
    1. If the test pulse is not present, replace U6.
    2. If the test pulse is present, suspect Q1 and associated components.

M.6.2.2 PWR And PTIM PALs

Problems with these PALs would be indicated by no or improper turn-on sequence action.

a. If a high TOR is sent to both of these PALs, begin checking the PWR PAL outputs and the Time pulses from the PTIM PAL. If no outputs are being activated, check for a clock pulse on both PALs. If the clock is not present troubleshoot clock generator. If the clock is present, replace U7 and if needed U8.
b. If the PWR PAL is receiving Time pulses and activating outputs, but no contactor action is occurring in the transmitter, check for active low outputs on J14. If not present suspect U43 and associated components.
c. Also check that the inputs from the contactors are reaching the PWR PAL. If not, suspect the Fault Input Latch.

M.6.2.3 FGATE1 And FGATE2 PALs

To troubleshoot these PALs start by verifying if the fault indicated is not an active low by measuring the input to the Controller board.

a. If the input is high, check the input to the PAL for a logic high.
    1. If a low is present replace the Latch for that fault.
    2. If a high is present, check for the clock input. If no clock input, troubleshoot the clock generator.
b. If the input is high, and the fault output is low, replace the PAL.

M.6.2.4 FLT1 And FTIM PALs

Problems with these PALs would be indicated by an incorrect ENTOR signal or no/improper A/C Restart or Overload fault response.

a. If the ENTOR output is low, check the FOFF, FOVR, FACR, and FBLIM inputs.
    1. If all inputs are high, check the clock inputs to both PALs. If not present, troubleshoot the clock generator. If present, replace U3 and U4 if needed.
b. If the A/C Restart and Overload functions are incorrect, replace both PALs.

M.6.2.5 FLDBK and FBTIM PALs

This should be accomplished using the same method as the Fault PALs.

M.6.2.6 Troubleshooting Clock Generator

The clock generator consists of an 8kHz clock that is divided down. Troubleshoot this circuit by using a scope and/or frequency counter to measure each divider IC for the proper frequency output at TP4 through TP8.

WARNING: Disconnect primary power prior to servicing.

M.7 Removal and Replacement

Remove the mounting screws and unplug all cables. In replacing the board, verify that P50, P52 and P53 are in the correct position.

M.8 Alignments

There are no alignments on this board.

M.9 LED Board

M.9.1 Introduction

This section describes the LED board, and includes circuit functions and descriptions, and maintenance and troubleshooting information.

NOTE: Parts List for this board is in Section VII.

M.9.2 Function

The LED board includes status indicator drivers for the Transmitter Status Panel. All the transmitter's front panel LED indicators are mounted on the LED board. The LED's are almost all Bicolor, meaning the LED can be either RED, for "Fault" or GREEN for "Normal".

M.9.3 Location

The LED board is located in the center PA cabinet on the back of the front door. (SEE VIEW 13)

M.9.4 Description

Refer to the LED Board schematic (839-7930-006) for the following. All LED Board inputs come from the Controller board, via J1 and J2. All Fault indicator inputs are active LOW, which means the LED will be RED when the Fault input is LOW. This means that the Fault input lines are normally HIGH, and the LED is GREEN. With no Faults present all LEDs on the Status Panel should be illuminated GREEN.

NOTE

Refer to Section M, Controller, for information on Transmitter fault types and Detailed descriptions.

M.9.4.1 Tri-State Buffers

U6, U7, U8 and U9 are used as Tri-State Buffers for all inputs to the LED board. Since it is a Buffer, the output will be the same as the input, provided the ENABLE line, pins 1 and 19 (of each chip) is LOW. If the enable line is HIGH, the LEDs will not light. This is done during Single Phase A/C failure to shut off all LEDs to save battery backup power.

Each output of the Tri-State Buffers go two places. Each goes to one side of the LEDs and at the same time goes to the input side of either U1, U2, U3 or U4.

M.9.4.2 Tri-State Inverters

U1, U2, U3 and U4 are used as Tri-State Inverters. The outputs of these inverters go to the LEDs on the side opposite of the Tri-State Buffer outputs. This assures that the LEDs will have a LOW on one side and a HIGH on the other, so the LEDs have to be either RED or GREEN. For example, if the oscillator RF Present line at J2-25 was HIGH, U6-18 would be high, which means the right side of DS1 would be HIGH (+5V), and the Inverter output U1-18 would be LOW making the left side of DS1 LOW, and the LED would be GREEN. This indicates a normal condition. If J2-25 was LOW, U6-18 would be LOW, which means the right side of DS1 would be LOW (0V), and the Inverter output U1-18 would be HIGH making the left side of DS1 HIGH, and the LED would be RED. This indicates a Fault condition.

M.9.5 Remote/Local Switch

Switch S1 is used to select either Remote or Local operation of the Transmitter. S1 is tied to +5.7 Volts and depending on whether it is in Remote or Local position determines which line to the Controller is also tied to +5.7 Volts, J1-9 Local or J1-7 Remote.

Provided that J1-3, Local Remote Enable is HIGH, Q1 will be saturated and will supply a ground to the cathode side of DS28 and DS29. With S1 in Local position, DS28 will light RED on the front Panel, and when in Remote position, DS29 will light GREEN. In the SLEEP mode, J1-3 Local Remote Enable, will be LOW and the Remote/Local LEDs, DS28 and DS29 will be disabled.

For more information on Remote/Local operation refer to Section M, Controller.

M.9.6 VSWR Test

VSWR test is a momentary switch used to test the transmitter VSWR protection circuitry. This supplies a LOW to the Controller which will then initiate the VSWR test. For more information on VSWR test and circuitry refer to Section H, Output Monitor/Output Sample and Section M, Controller.

M.9.7 Fault Reset

Indications can be RESET by depressing the "RESET" pushbutton on the transmitter's status panel or by providing, a remote "Reset" command. The indications will then change from RED to GREEN if the fault has cleared.

EXCEPTIONS: DOOR INTERLOCK and EXTERNAL INTERLOCK status indications clear as soon as the door is properly closed or the cause of the external interlock is corrected.

M.10 Switch Board/Meter Panel

M.10.1 Introduction

This section describes the Switch Board/Meter Panel. Topics include Function, Location, Detailed Curcuit Description, and Troublehsooting.

NOTE: Maintenance/Alignments for this board are covered in Section V and Parts List in Section VII.

WARNING: Disconnect primary power prior to servicing.

M.10.2 Function

Components mounted on the Switch Board/Meter Panel include the transmitter's on/off and raise/lower control pushbutton switches and status indicators, forward/reflected power metering and calibration, 230VDC power supply voltage metering and calibration control, 230VDC power supply current metering, and protective diodes and bypass capacitors for the meters.

M.10.3 Location

The Switch Board/Meter Panel is located on the back side of the center cabinet's front door. (SEE VIEW 13)

M.10.4 Detailed Circuit Description

Refer to the Switch Board/Meter Panel Schematic Diagram (839- 6208-098), for the following discussion.

M.10.4.1 Pushbutton Switches S1-S6

When each pushbutton switch is depressed, it provides a +15 Volt input to the transmitter on/off control circuits on the Controller Board.

M.10.4.2 Indicator Lamps DS1-DS5

The indicator lamps are physically located behind the pushbutton switch caps, so that the pushbutton switch illuminates when the indicator lamp is on. One side of each indicator lamp is connected to the +15 Volt bus on the circuit board, and the other side of each lamp goes to a transistor collector on the Controller Board.

M.10.4.3 Meter Protection

Each meter is protected with two 1-Ampere diodes connected across the meter terminals. Excessive voltage across the meter movement will cause the diodes to conduct, shunting current around the meter. An RF bypass capacitor is also placed across the meter terminals. All protective components are located on the switch board/meter panel printed circuit board.

M.10.4.4 Multimeter M1

A 2-pole 11 position switch (with 8 positions used) connects the meter to the desired metering circuit. For voltage scales, meter multiplier resistors are located on other transmitter circuit boards. For current scales, the multimeter acts as a voltmeter, measuring the voltage drop across a resistor in the desired current path. In the PA +VDC position, potientometer R4 and series resistor R3 are used for calibration purposes.

M.10.4.5 Supply Current Meter M2

The meter M2 is connected directly across shunt SH1. The current shunt is connected from the negative side of the 230 Volt power supply to ground. The voltage developed across the meter shunt is proportional to the power supply current. This voltage is also routed to the Controller Board for overcurrent fault sensing.

M.10.4.6 Power Meter M3

The power meter circuit includes a switch to select either the Forward Directional Coupler output or the Reflected Directional Coupler output, and potentiometers to calibrate the meter indications. The directional couplers are located on the Output Monitor Board.

M.10.5 Troubleshooting

M.10.5.1 Changing Indicator Lamps

To change indicator lamps, carefully remove the plastic cap from the pushbutton switch to gain access to the indicator lamp. The plastic cap can be removed by carefully pulling it straight out from the front of the panel.

M.10.5.2 Metering Circuit Fault

Failure of the operational amplifier driving the meter could cause either no indication or a full scale indication. If it is suspected that multiplier resistor values have changed value, they can be checked in-circuit, if the multimeter is switched to some other position to eliminate parallel resistance paths.

WARNING: Disconnect primary power prior to servicing.

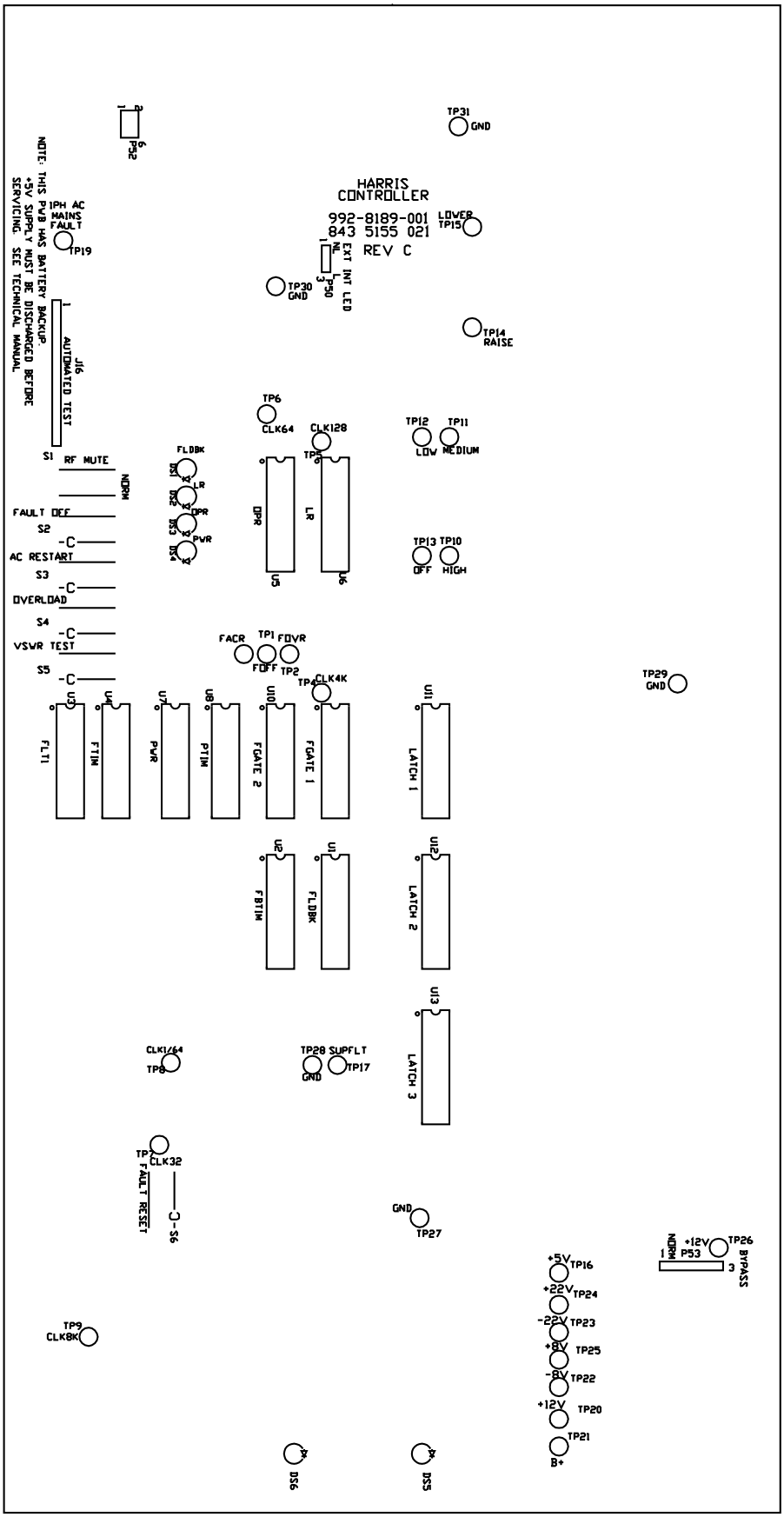

Figure M-11. Controller Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

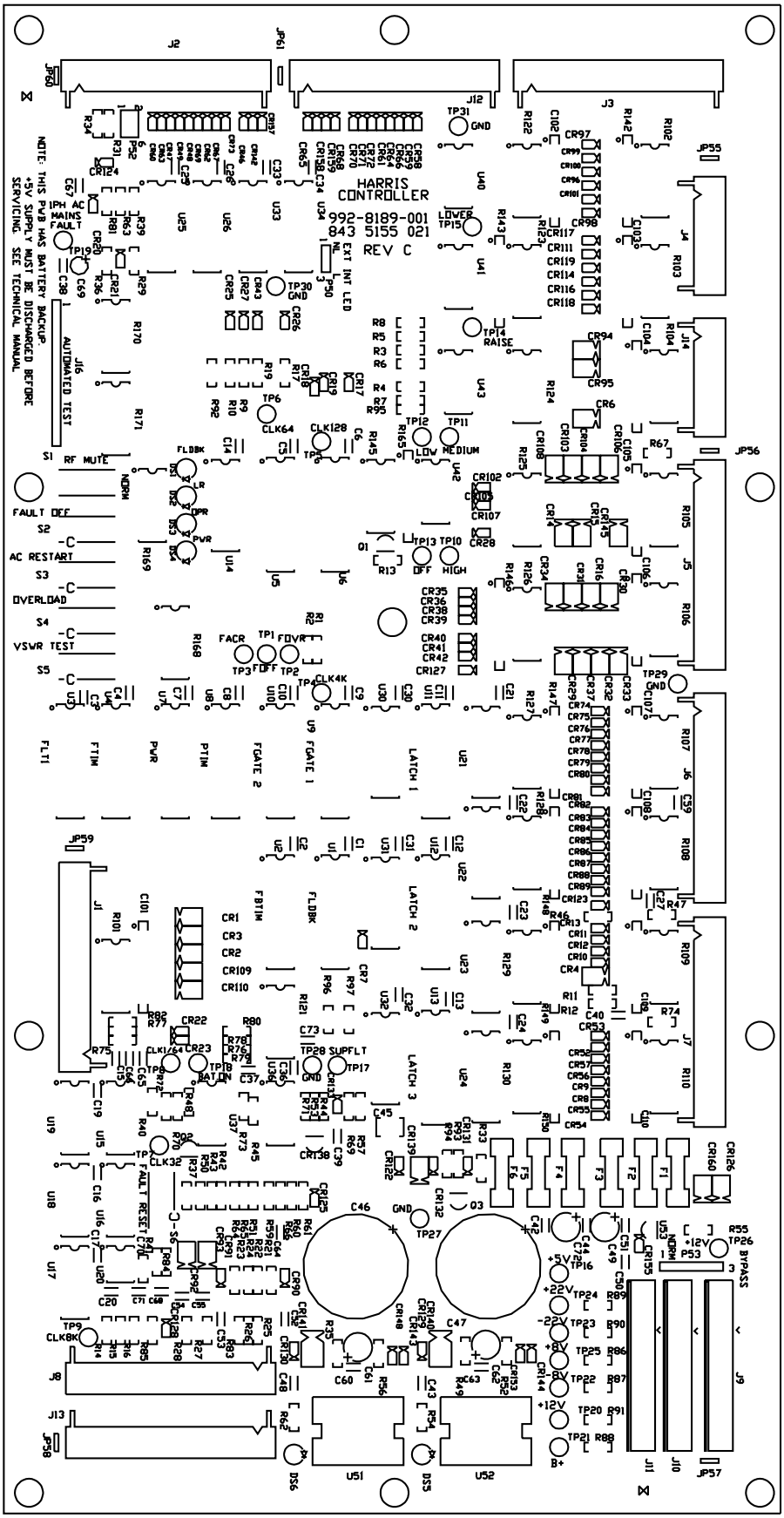

Figure M-12. Controller Component Locator

WARNING: Disconnect primary power prior to servicing.

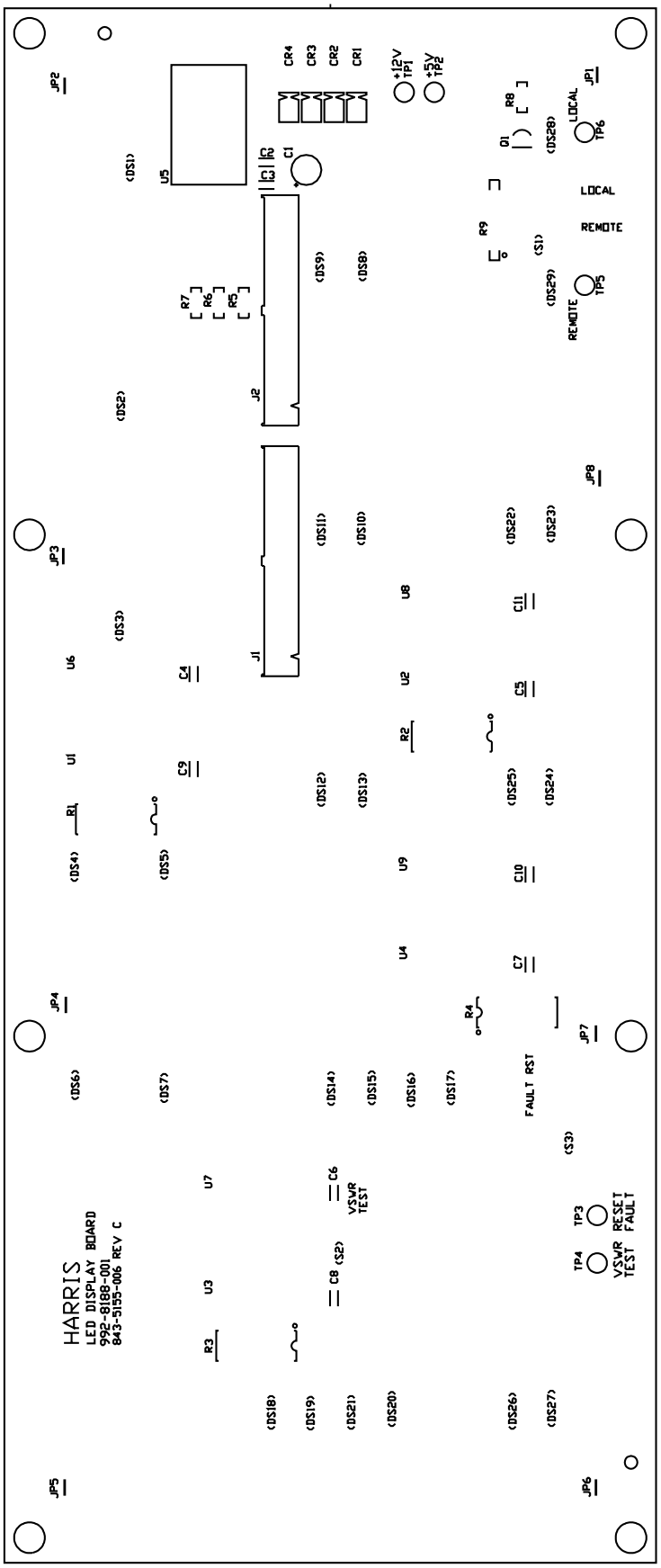

Figure M-13. LED Display Board Component Locator

WARNING: Disconnect primary power prior to servicing.

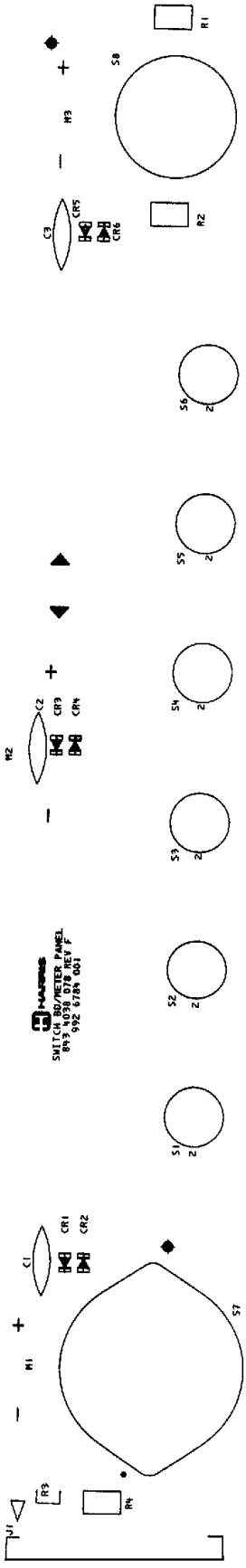

Figure M-14. Switch Bd/Meter Panel Component Locator

WARNING: Disconnect primary power prior to servicing.

Section N
External Interface (A23)

N.1 Introduction

This section describes the External Interface board. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

NOTE: Parts List for this board is covered in Section VII.

N.2 Function

The External Interface board receives Remote Control Inputs and provides Remote Status and Metering Outputs. It also contains the Audio Input Connections and the External Interlock circuit.

N.3 Location

The External Interface Board is located behind the center front door.(SEE VIEW 12)

N.4 Detailed Circuit Description

Refer to the External Interface Schematic (839-7930-017) and to the External Interface Chart (839-7930-162) for the following discussion.

NOTE

Several circuits on the External Interface board have been reserved for use only when in a combined transmitter operation. If any part of the schematic is blocked in using dashed lines, these components may not have been installed for single transmitter operation. Their use in combined operation is discussed in the manual for combined transmitters.

N.4.1 Remote Status Outputs

Several fault indications, as well as LOW, MEDIUM, HIGH, and OFF transmitter modes can be monitored using the status outputs. J7 supplies inputs from the Controller to the status output drivers U1, U2, and U6, except for the RF Mute Status.

The operation of all the output drivers are the same. These drivers provide isolation between the Controller and the external remote control circuits. When the input to an output driver is pulled low by the Controller, the driver's output also goes low.

This output can be used to illuminate an LED or turn on an opto-isolated status input to a remote control system. The output can also be used to activate a relay, however current through the output driver and the output resistor should be limited to 100 mA. The voltage must be limited to a maximum of +15 VDC.

Examples of TTL logic and Relay outputs are shown in Figure N-1.

Should transient voltages develop on the remote status lines, protection diodes on the output of each driver will clamp the output at +15.6 VDC or -0.6 VDC.

A regulated +15 VDC at 100 mA is provided at J4-18 for use with the Remote Status Outputs. If a larger current supply is needed, an external power supply should be used.

Two drivers have jumpers on their input. The Interlock Open and the LV Supply Fault status drivers will have jumpers P25 and P26 positioned from 1-2 for single transmitter operation.

The Transmitter Select Switch S1 is also provided for combined transmitter operation. For single transmitter operation S1 is jumpered to the Master position and therefore supplies a Switch Ground for U1 and U6.

A second output for LOW, MEDIUM, HIGH, and OFF is provided for combined transmitter operation through J3-1 thru 4.

N.4.2 Remote Control Inputs

All Remote Control functions are accomplished through optically isolated control inputs using opto-isolators U3, U4 and U5. All inputs are programmable to accept either high or low control inputs.

The Remote Control Inputs are enabled by an active high from the Controller board at J7-9. This voltage will turn on transistor Q1, which provides a ground for the emitter of each opto-isolator. The only exception is the RF Mute Control. Remote Control Active status is provided by Q5.

A jumper plug is provided on the input of each opto-isolator to allow programming for high or low control logic.

NOTE

All inputs must be configured the same way.

With the input jumpers P1 thru P11 positioned as shown in Figure N-2, a ground applied to the control input will activate the control function.

With the input jumpers P1 thru P11 positioned as shown in Figure N-3, +5 VDC applied to the control input will activate the control function.

Figures N-4 and N-5 show examples of remote control from relay contact or TTL logic level inputs.

The Remote Control Inputs are connected to 37 pin "D" connector J6. A terminal strip adapter is provided for use with the "D" connector.

A regulated +5 VDC is provided at J6-18 for use with the Remote Control Inputs. If an external power supply is used it should be limited to a maximum of +15 VDC.

Parallel inputs are provided for combined transmitter operation via J5 for LOW, MEDIUM, HIGH, OFF and RF MUTE.

N.4.3 Metering Outputs

N.4.3.1 Remote Metering

Operational amplifiers U14, U15 and U16 provide Remote Metering for six transmitter parameters.

WARNING: Disconnect primary power prior to servicing.

FORWARD POWER, SUPPLY VOLTAGE and SUPPLY CURRENT outputs will be between 2 and 4 VDC under normal operating conditions.

REFLECTED POWER, ANTENNA NULL and NETWORK NULL outputs should be near 0 VDC and will increase as corresponding front panel meter readings increase.

NOTE: Refer to the Installation Section for Typical Remote Metering applications.

N.4.3.2 External Metering

Four additional customer selected parameters may be monitored on both the front panel multimeter and from remote metering by utilizing operational amplifiers U8 thru U11. These parameters may be from inside or outside the transmitter, but maximum voltage limits should be observed.

For EXT 1 and 3, a maximum voltage of +8 VDC can provide a full scale reading on the front panel multimeter.

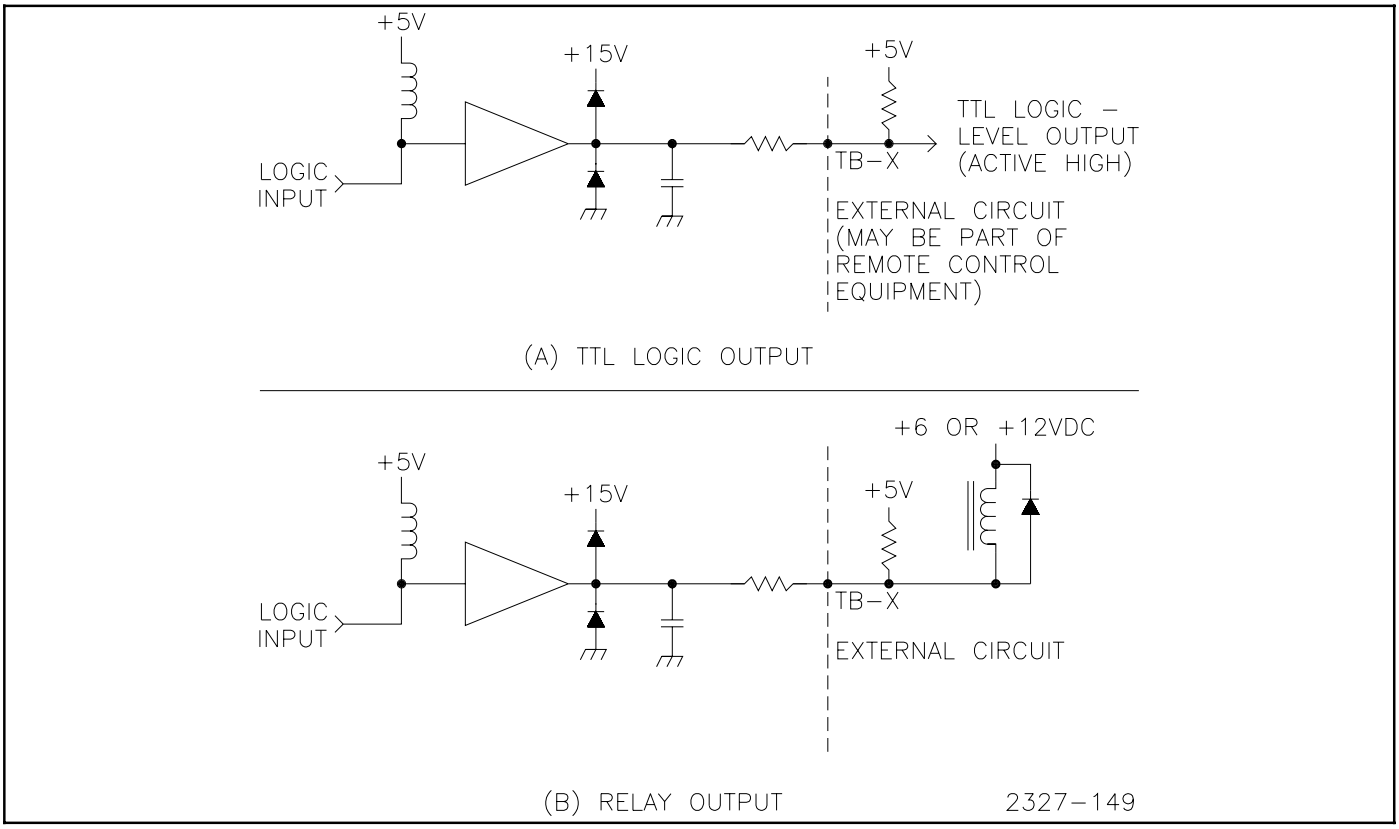

Figure N-1. TTL Logic and Relay Outputs

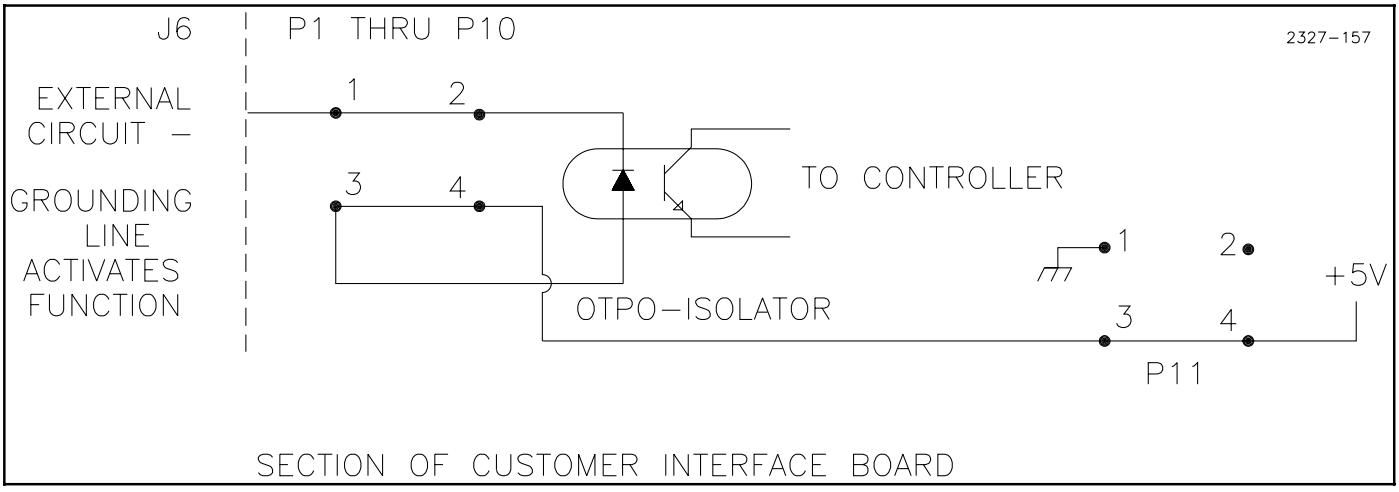

Figure N-2. Ground Switching

WARNING: Disconnect primary power prior to servicing.

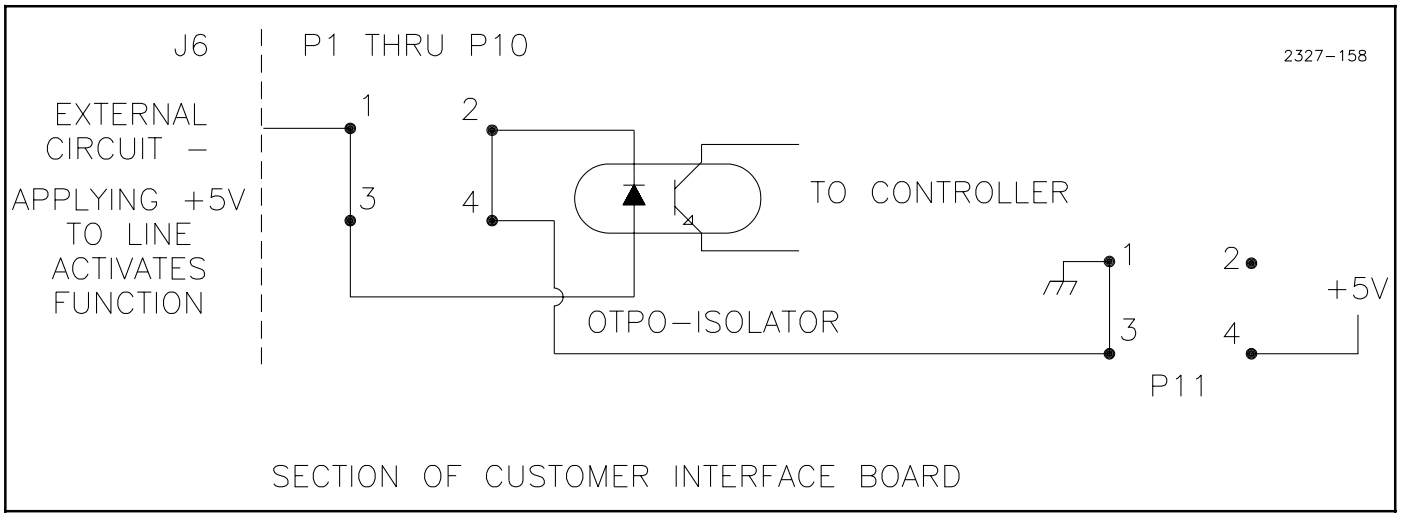

Figure N-3. Voltage Switching

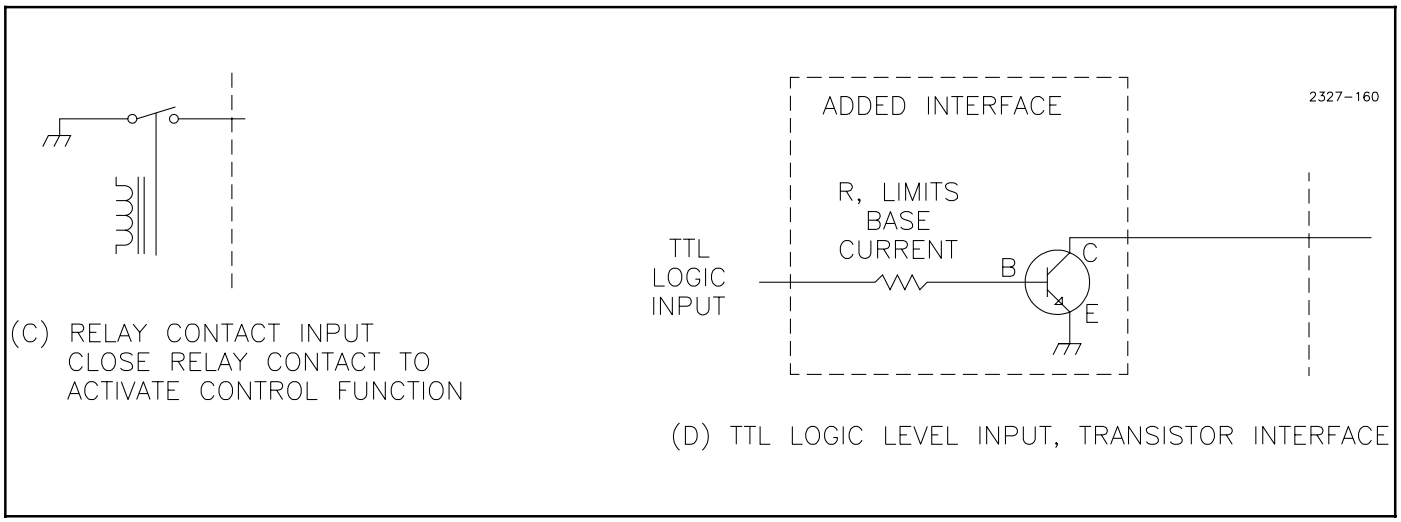

Figure N-4. Remote Control for Ground Switching

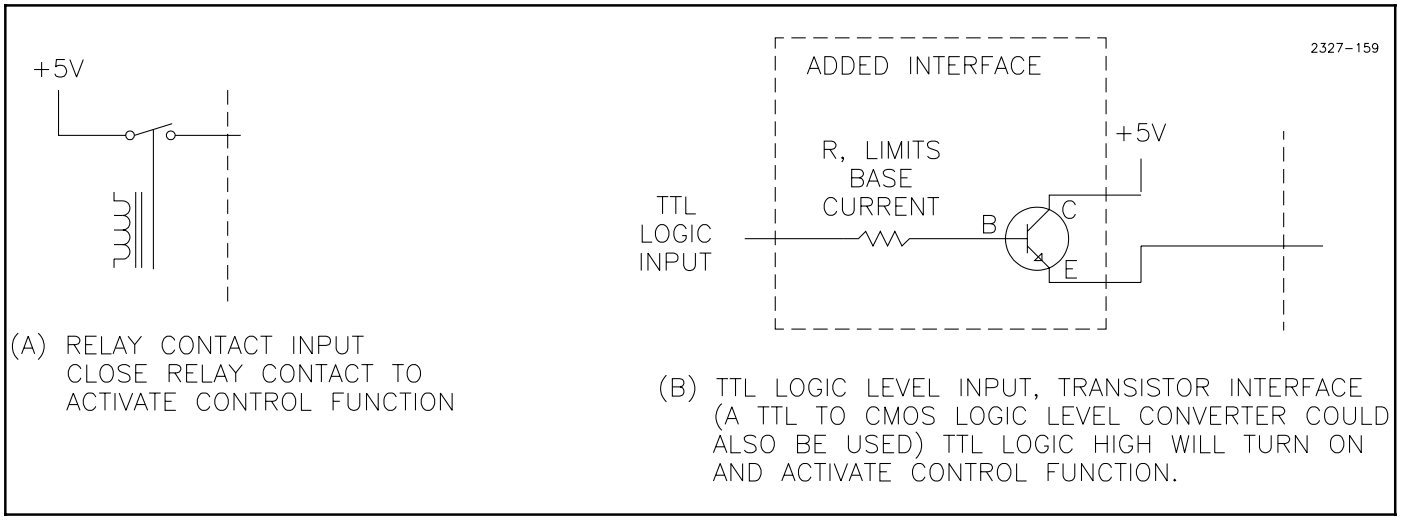
+5V
2327-159
ADDED INTERFACE
R, LIMITS BASE CURRENT
+5V
TTL LOGIC INPUT
B
C
E
(A) RELAY CONTACT INPUT
CLOSE RELAY CONTACT TO ACTIVATE CONTROL FUNCTION
(B) TTL LOGIC LEVEL INPUT, TRANSISTOR INTERFACE (A TTL TO CMOS LOGIC LEVEL CONVERTER COULD ALSO BE USED) TTL LOGIC HIGH WILL TURN ON AND ACTIVATE CONTROL FUNCTION.

Figure N-5. Remote Control for Voltage Switching

WARNING: Disconnect primary power prior to servicing.

For EXT 2 and 4, a maximum voltage of +15 VDC can provide a full scale on the front panel multimeter.

Inputs to the operational amplifiers are through terminal board TB1. The outputs at J8 are sent to the front panel multimeter switch and "D" connector J2 provides remote External Metering outputs.

There are no provisions within the transmitter for calibration of the remote EXT outputs. This may be accomplished with the use of a potentiometer in series with the remote meter or control device.

N.4.4 Demodulated Audio Sample

A demodulated audio sample from the Output Monitor board, is buffered by U17 and is available at terminal board TB1-15 and 16. This audio sample, although it has reasonably low distortion, is intended for general monitoring use. A modulation monitor is recommended for performance measurements.

N.4.5 External Interlock

When the transmitter is in the Test Mode, the External Interlock relay K1 is held energized from the +22 VDC power supply, through P29 1-2 and the normally closed customer supplied External Interlock contacts from TB1-7 to TB1-8. When the transmitter is in the Standby Mode, the +12 VDC supply is used to energize K1.

When the relay is energized, a logic high is sent to the Controller at J9-29 from the closed contacts of K1 4-7.

If the External Interlock is opened, the relay contacts will open and the voltage at J9-27 will be low. The Controller will turn the transmitter OFF.

NOTE

The transmitter will not operate if there is an open circuit between the External Interlock terminals.

Jumper plug P29 and a second set of contacts on the External Interlock relay are provided for combined transmitter operation.

N.4.6 Audio Input

The audio input is applied across terminal board TB1-1 (+) and TB1-2 (-). Bipolar zener diodes CR66 and CR67 from each side of the balanced audio input to ground and provides overvoltage protection. Audio is then sent to the Analog Input board where jumpers are used to select an input impedance of between 50 Ohms and 600 Ohms.

N.4.7 Power Supplies

Three voltages are supplied from the Power Distribution board. A +22 VDC and -22 VDC are regulated down to +15 VDC and -15 VDC by U18 and U19. The +12 VDC input is regulated down to +5 VDC and is current limited by R75 and R76. These supplies are used to power various circuits on the External Interface board. In addition, the +15 VDC and +5 VDC supplies may be used to power Remote Control Inputs and Status Outputs.

N.5 Troubleshooting

N.5.1 Remote Control Input(s) Do Not Operate

a. If +15VDC from J4-18 or +5VDC from J6-18 is used, check for presence of this voltage.
b. If voltage is missing, check the associated power supply input and voltage regulator.
c. If a customer-supplied battery or power supply is used, check its output voltage.
d. While monitoring the DC voltage between the control input terminals on J6, activate the remote control equipment.
e. If the voltage between the terminals is 15 Volts or more, the problem is in the transmitter.
f. If the voltage is small, the problem is a shorted opto-isolator input or the problem is external to the transmitter.
g. To determine whether the opto-isolator or transmitter logic is at fault:
    1. Monitor the voltage across the opto-isolator's output terminals or J8, while activating the remote control input again.
    2. If the voltage across the opto-isolator's output terminals drops to less than 0.5 Volts, the opto-isolator is operating properly.

Additional Notes: Current through the control input terminal circuit turns on an opto-isolator by illuminating an internal LED. A current between 40 and 70 milliamperes is required to illuminate the LED and activate the photo transistor.

N.5.2 Incorrect Status Output(s)

A positive voltage through circuits external to the transmitter must be supplied to each status output used, at the proper terminal of J4.

For each Remote Status Output, when there is no red status indication on the transmitter status panel or illuminated pushbutton switch, there should be a positive voltage on the corresponding terminal of J4.

a. Determine the source of the supply voltage for external status circuits, then check that supply.
b. Use a voltmeter or logic probe to check the input voltage to the status interface circuit.
c. When there is a "status" indication (red LED or illuminated pushbutton switch), the corresponding terminal should be low.
d. If the input is low, the output should also be low.
e. If not suspect a defective driver.
f. If the input is high, the problem is in the transmitter fault logic.

Further troubleshooting depends on remote control unit or remote indicator circuits used.

WARNING: Disconnect primary power prior to servicing.

N.5.3 Incorrect Remote Metering

Each analog voltage to the monitor output terminals is buffered by a voltage follower. Measure the +15 and -15VDC supplies, and check output zener diodes. Failure of the zener diode might result in low or no output from the op amp.

N.6 Removal and Replacement

Remove the cable connectors going to this board. Then remove the mounting screws to remove the board from the transmitter. Reverse the above procedure when replacing the board. Note that the connectors are numbered and keyed to aid in making the connections.

Note all jumper positions and verify the replacement board is properly jumpered.

N.7 Alignments

If the External Metering options are used, adjust the appropriate potentiometers for previous recorded readings. Ensure that all jumpers are in the correct positions.

WARNING: Disconnect primary power prior to servicing.

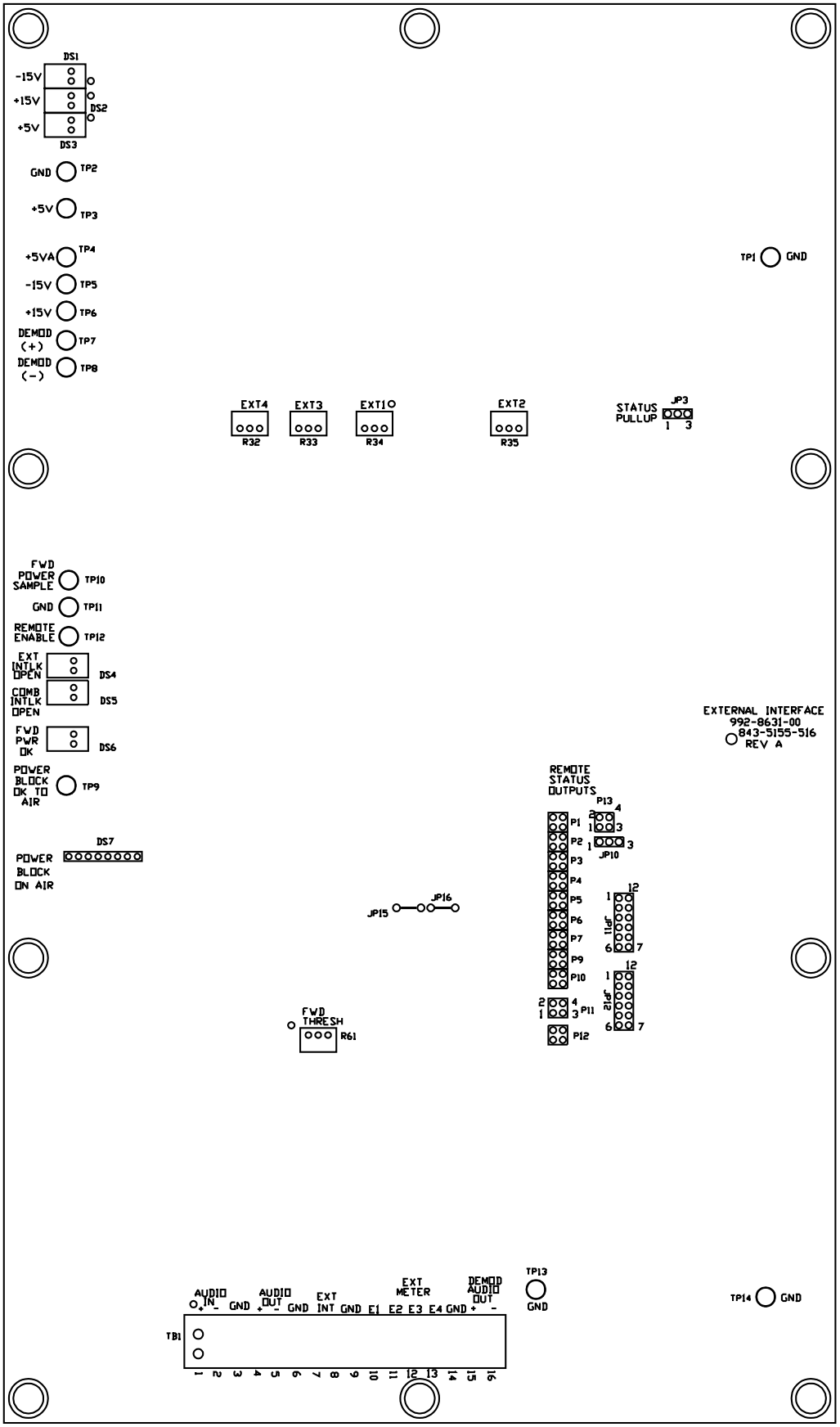

Figure N-6. External Interface Controls & Indicators

WARNING: Disconnect primary power prior to servicing.

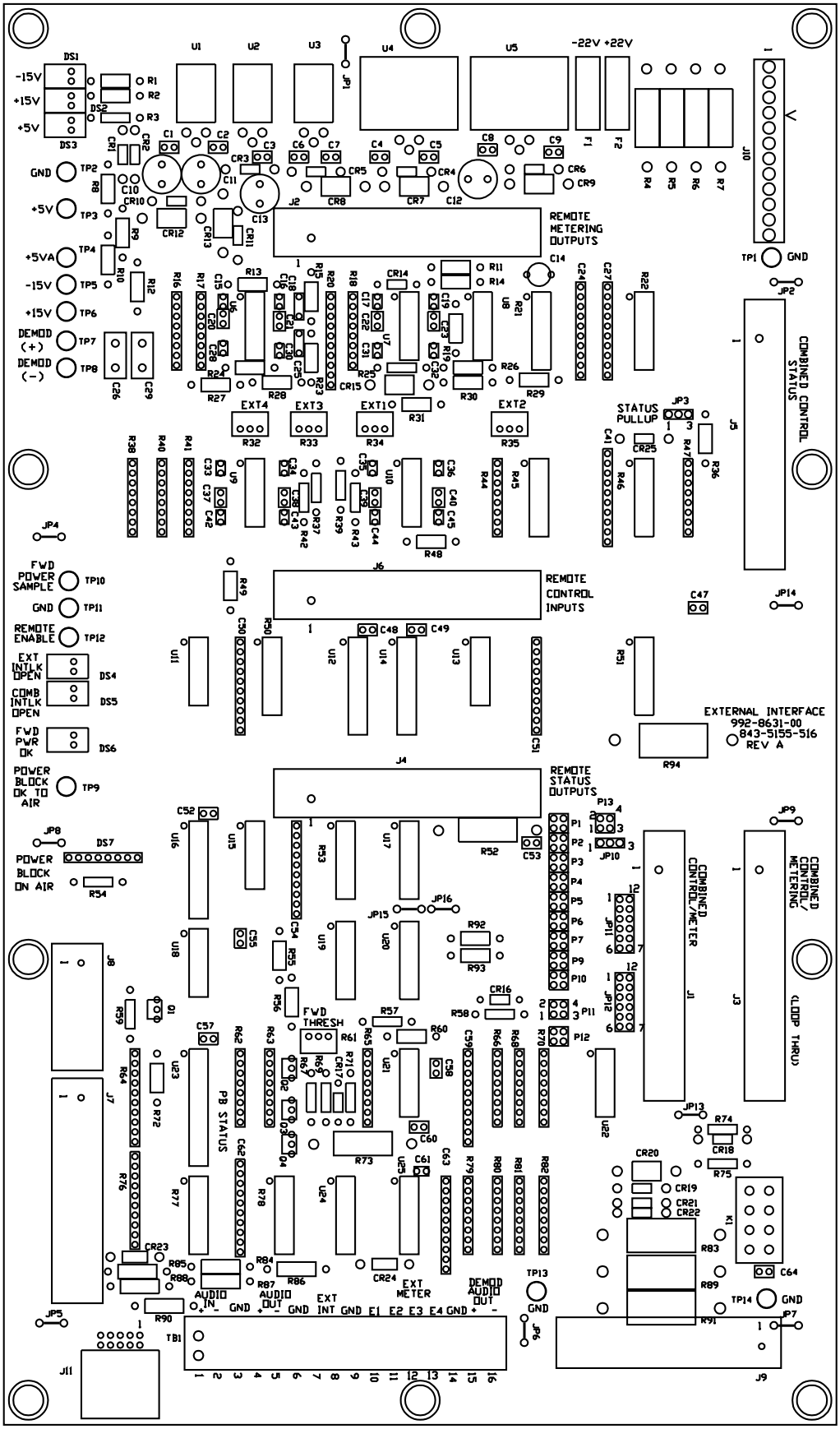

Figure N-7. External Interface Component Locator

WARNING: Disconnect primary power prior to servicing.

WARNING: Disconnect primary power prior to servicing.

P.1 Introduction

This section describes the Transmitter Interface board. Topics include function, location, detailed circuit description, troubleshooting, and removal/replacement.

NOTE - Parts List for this board is covered in Section VII.

P.2 Function

The primary function of the Transmitter Interface board is to act as a tie point for inputs/outputs to and from the Controller board, to the rest of the transmitter. In this way, the Transmitter Interface greatly increases reliability by decreasing the number of cables and connections to and from the circuitry mounted on the hinged front door, most of which go to the Controller.

Other functions include Cable Interlock summing, Control Multimeter monitoring, Power Supply interconnections, Battery Backup connections, and Interlocks.

P.3 Location

The Transmitter Interface board is mounted in the center PA compartment on the left hand wall (SEE VIEW 12).

P.4 Detailed Circuit Description

Refer to the Transmitter Interface Schematic 839-7930-512 for the following discussion.

P.4.1 Cable Interlock

All Cable Interlock inputs from the 5 Modulation Encoders and the Driver Encoder are applied to inputs of AND gate U3. Provided all of the inputs are high, the output of U3-8 will also be high and this will allow normal transmitter operation. If a Cable Interlock - L is generated on any of the 5 Modulation Encoder boards or the Driver Encoder board, the output of U3-8, will go low and the Controller will shut the transmitter OFF.

P.4.2 Control Multimeter

Switch S1, along with U1 and U2, allows metering of 3 positive and 3 negative voltages on the Control Multimeter using only 3 of the meter positions.

With S1 relaxed, monitoring of the +22, +8, and B+ voltages is accomplished by moving the Control Multimeter switch to the respective positions.

With S1 depressed, monitoring of the -22, -8, and B- voltages is accomplished using the same three respective positions on the Control Multimeter.

P.4.3 Power Supply Interconnect

All power supply voltages from the Power Distribution board pass through the Transmitter Interface and on to the Controller where they are then distributed to the rest of the boards mounted on the door. Test points, TP1 thru TP7, are provided on the Transmitter Interface for the +22, -22, +8, -8, B+ and B- voltages.

The Controller supplies +5 VDC at J1-23 to several circuits on the Transmitter Interface. It can be measured at TP8. This same +5 VDC supply is then sent, via J10-35, to the External Interface board where it becomes +5VB.

The External Interface supplies +15 VDC and -15 VDC for the Control Multimeter on the Transmitter Interface at J10-37 and 39. These voltages can be measured on TP12 and TP13.

P.4.3.1 Battery Back-up

Battery holders for 4 AA size batteries are mounted on the Transmitter Interface. If you desire memory back-up for longer than 10 minutes when primary power is removed, AA size primary cells (batteries) should be installed in the holders. Diodes prevent reverse current flow through the batteries.

NOTE

Do not use rechargeable batteries, such as NiCad batteries. This circuit is not designed to recharge batteries.

Ordinary carbon batteries can be used, but alkaline batteries are recommended, as they are less likely to leak and their longer "shelf life" will be an advantage in this low-current application.

Note

Do not install back-up batteries unless C46 and C47 are charged (+5B voltage at TP16 is greater than 4.5 Volts). Current drain from the batteries during charging of C46 and C47 will shorten battery life.

P.4.3.1.1 Replacing Batteries

Because of the very low current drain, the life of back-up batteries should approach the battery shelf life. It is recommended that batteries be replaced at least once every 6 months. This will ensure that they will operate properly should they be required.

P.4.3.1.2 External Battery Input

Any +6VDC voltage source may be connected to TB1-1 (+) and TB1-2 (-) to be used as a battery backup.

Both the External Battery Input and the Internal Batteries are connected to the Controller at J16-12.

P.4.3.1.3 Power Supply Monitor

U5 normally connects the +5VDC supply from the Controller at J1-23 to the +5VDC output that is connected to the Frequency Control Interface. If AC power is lost, at the point where the Controller will switch to the Battery supply at J16-12, U5 will also connect the +5VC supply to J16-12, via 3 dropping diodes. The +5VC supply is used to maintain memory for the frequency control circuits.

WARNING: Disconnect primary power prior to servicing.

P.4.4 Interlocks

The transmitter contains dual contact interlock switches on all rear doors and on the inner front doors. One set of contacts is used for the Door Interlock and the other is used for the Control Chain Interlock. If any of the eight hinged doors are opened both interlock strings will be broken and the transmitter will be shut OFF.

NOTE

The Power Supply Access Interlock is not used in single transmitter operation.

P.4.4.1 Door Interlocks

Refer to Figure P-1, Simplified Front and Rear Door Interlock Status String for the following discussion.

P.4.4.1.1 Front Door Interlock String

"Front Door", in this case, is referring to the Inner doors, inside the 3 PA compartments. When the transmitter is in the Standy Mode, +12 VDC is applied thru diode CR12 to the interlock string at J7-5. When the transmitter is in the Normal Mode, +22 VDC is applied thru diode CR7 to J7-5 and diode CR12 is then reverse biased. In either case, a voltage is supplied to the interlock string at J7-5.

When all 3 doors are closed, the voltage will be present at J7-6, and to the base of Q2 via R46 and R45. This will saturate Q2 and shut off DS1, indicating all front doors are safely fastened.

When all Rear Doors are also closed and the ground sticks are in the clip holders, J1-27 will be connected to this voltage and the transmitter is operational.

If any of the front doors are opened, J7-6 would go low and Q2 will turn off and illuminate DS1 RED. The Door Interlock line at J1-27 will also go low because the voltage has been removed, and the Controller will shut OFF the transmitter.

P.4.4.1.2 Rear Door Interlock String

When the Front Door Interlocks are closed, the voltage will be applied to this string at J7-7. This string includes the 5 rear doors, both ground stick interlocks, and 4 terminal strip connections. If all doors are closed and both ground sticks are in place, J1-27 will be high and Q1 will be saturated turning DS2 off.

When a Rear door is opened, the Door Interlock line at J1-27 will go low shutting the transmitter OFF and Q1 will illuminate DS2 RED.

NOTE

If both a rear door and a front door are open at the same time, only DS1 will be illuminated. Once the front door is closed, DS1 will shut off and DS2 will then illuminate. Once the rear door is closed, DS2 will shut off.

P.4.4.2 Control Chain Interlock

Refer to Figure P-2 , Interlock Control Chain for this discussion.

If the External Interlocks have been implemented on the External Interface, a similar +22/+12 VDC from the External Interface is

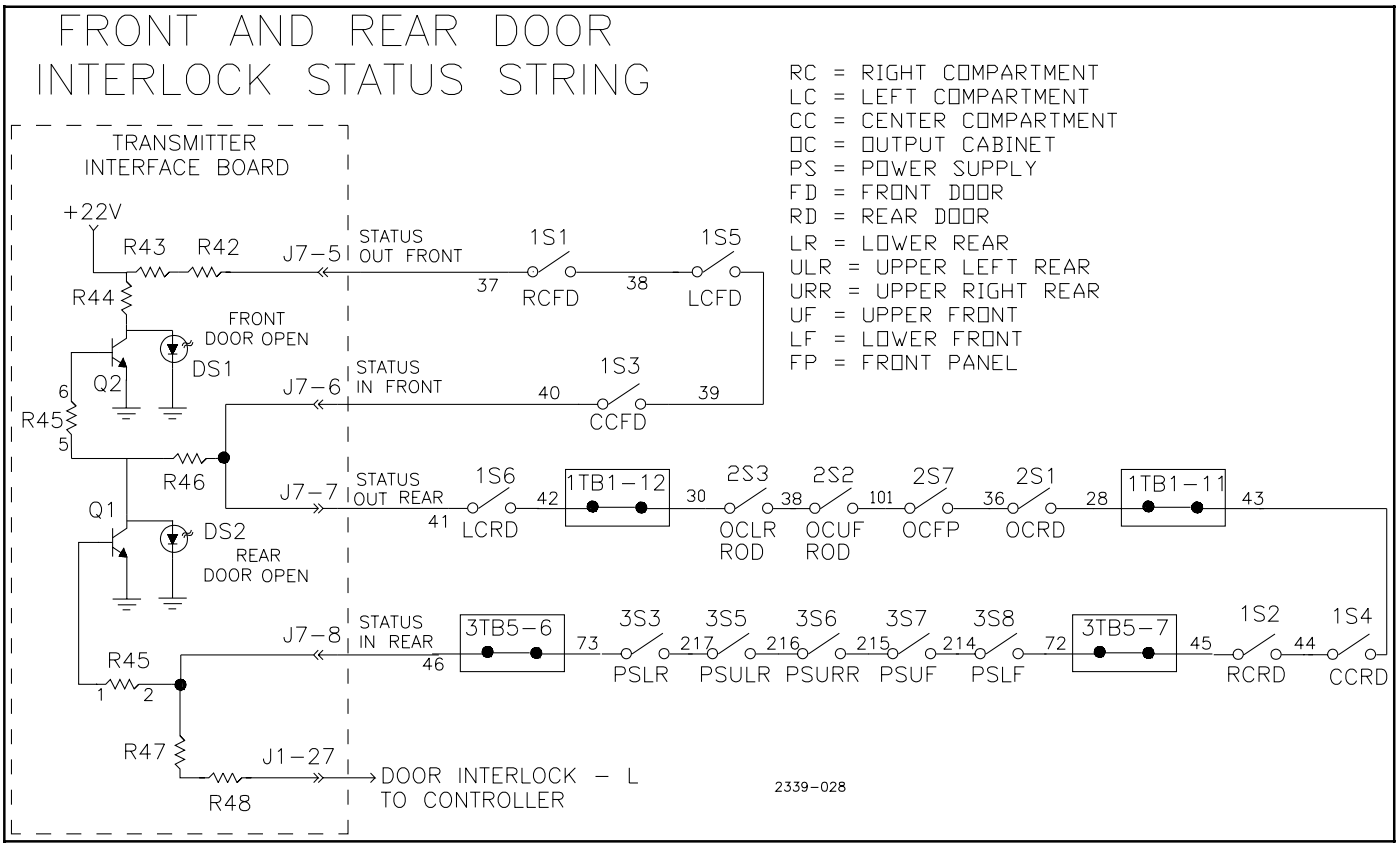

Figure P-1. Front & Rear Door Interlock Status String

WARNING: Disconnect primary power prior to servicing.

supplied to J10-29 on the Transmitter Interface. This voltage is sent out on J7-1 to the three inner front door interlocks. If all the front inner doors are closed the voltage returns to the Transmitter Interface board on J7-2. This voltage is sent back out on J7-4 to the five rear interlocks. If all the doors and ground stick switches are closed the voltage is connected to the anodes of the solid state relays K3 and K4. When the Controller calls for a Contactor to close to turn on the transmitter the Controller supplies a ground to the cathode of the respective solid state relay through the Transmitter Interface board and Driver Encoder board.

If any one of the eight doors are opened, the voltage for both solid state relays is disconnected and the transmitter is shut OFF.

P.4.5 Circuit Board Interfaces

The rest of the Transmitter Interface board is input and output connections between the circuit boards mounted on the back of the front door and other boards in the transmitter.

P.5 Troubleshooting Transmitter Interface

P.5.1 Interlock Status

Troubleshooting the interlock is done by using the Interlock Status and Interlock Control Diagrams located at the end of this section and a meter to measure continuity and voltage.

P.5.2 Metering Amps

The samples +22VDC, -22VDC, +8VDC, -8VDC, B+ and B- for the Control Multimeter are generated on this board.

a. If any of these are lost, verify the presence of the voltage on U1 or U2.

b. If the voltage is present replace the U1 or U2 associated with that sample.

c. If not present refer to the overall wiring diagram to trace the missing voltage.

P.5.3 Cable Interlock

The five Mod Encoder Interlocks are summed on this board at U3.

a. If a fault is suspected check U3-8.

b. If this is low check the input pins 1 through 5 and 13 for a logic high.

c. If all the pins are high replace U3.

d. If any of these are low refer to the Mod Encoder section to troubleshoot an interlock fault.

The rest of the board consists of pass through connections. Refer to the Transmitter Interface Schematic to trace the signal through the Interface board.

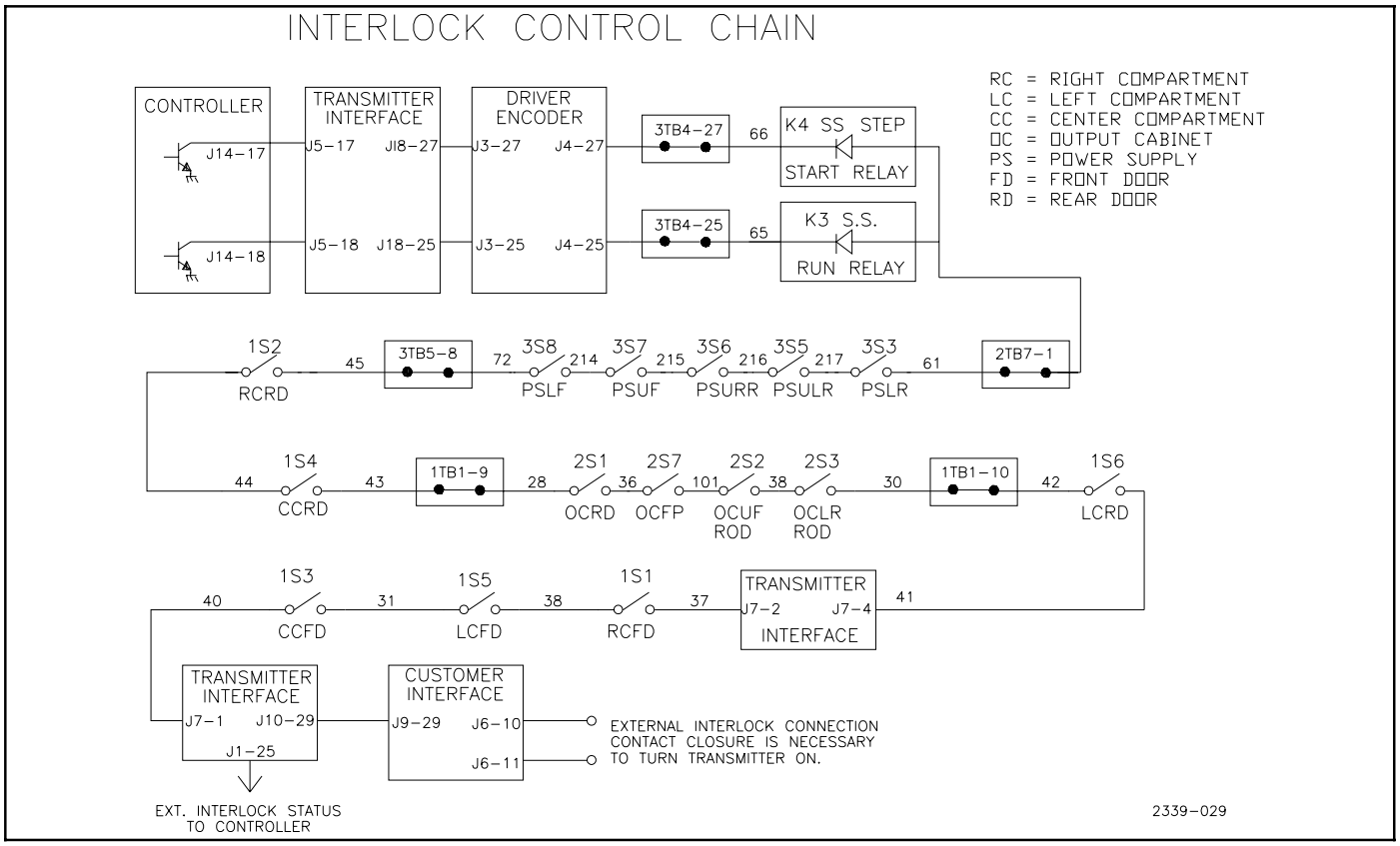

Figure P-2. Interlock Control Chain

WARNING: Disconnect primary power prior to servicing.

P.6 Removal and Replacement

Remove the 24 cable connectors going to this board. Then remove the 8 mounting screws to remove the board from the transmitter. Reverse the above order when replacing the board. Note that the connectors are numbered and keyed to aid in making the connections. Note all jumper positions and verify the replacement board is properly jumpered.

P.7 Alignments

There are no alignments needed on this board; however, ensure that P1 is in the proper position.

WARNING: Disconnect primary power prior to servicing.

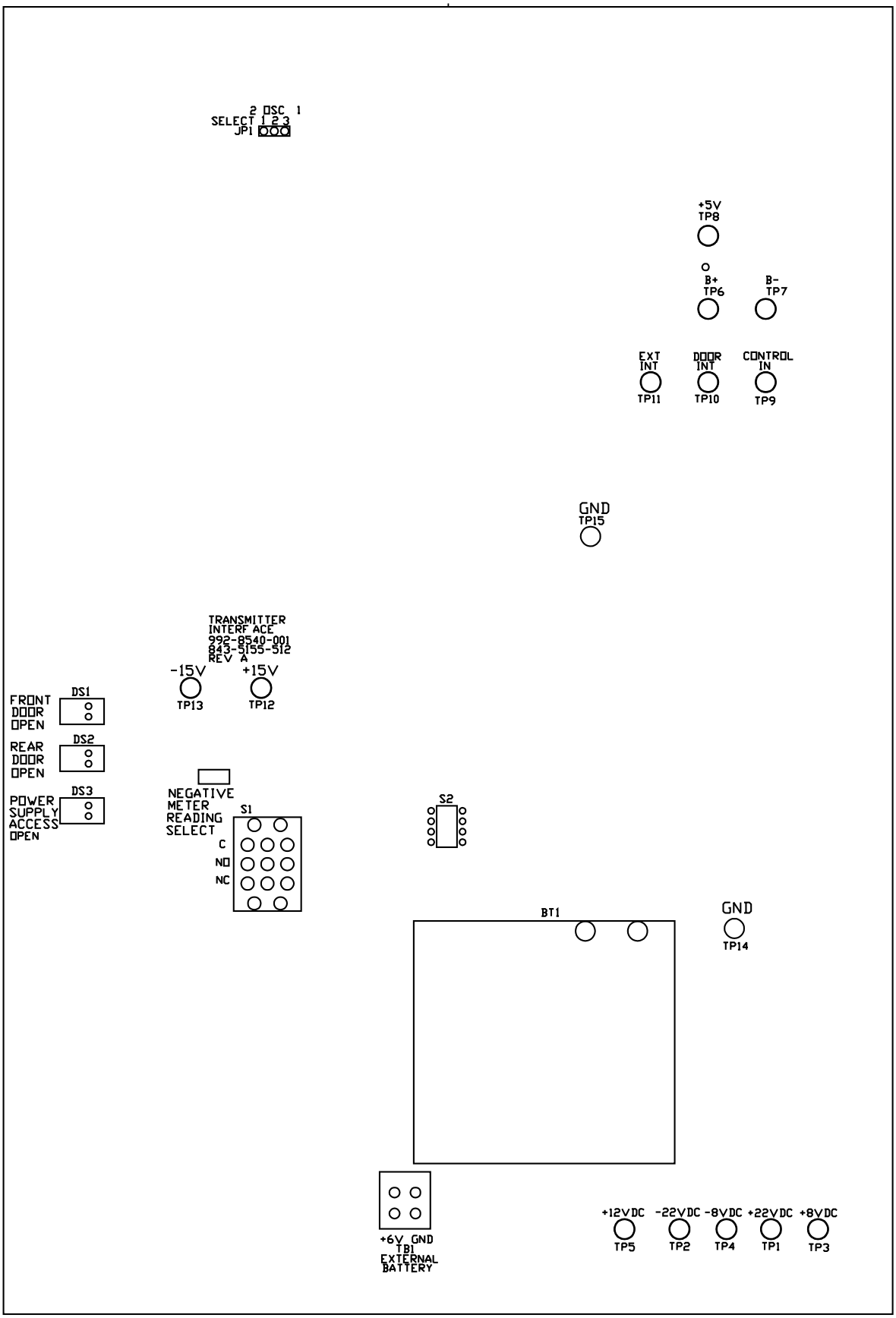

Figure P-3. Transmitter Interface Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

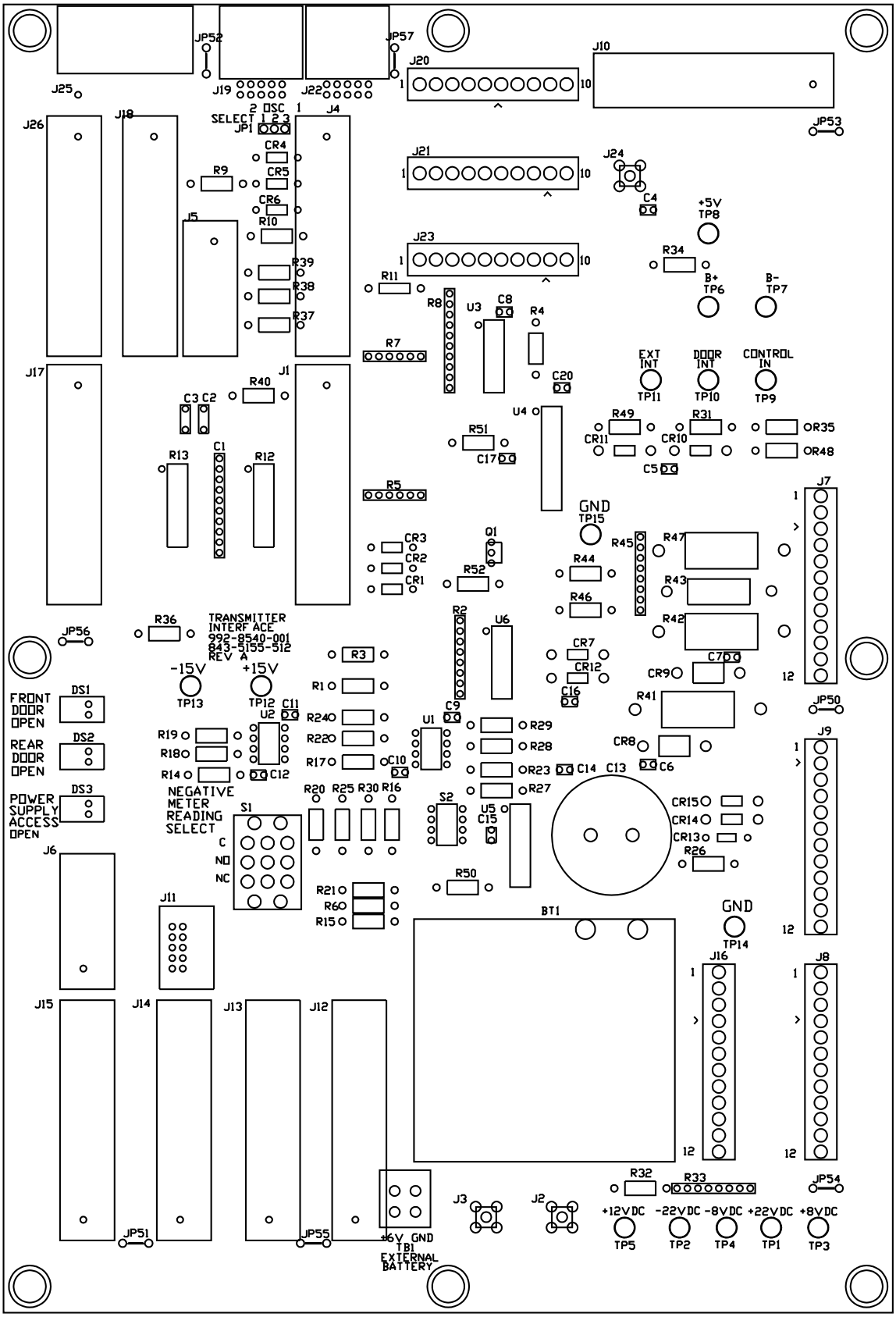

Figure P-4. Transmitter Interface Componet Locator

WARNING: Disconnect primary power prior to servicing.

Q.1 Introduction

This section covers the Frequency Control board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, removal/replacement, and alignments.

NOTE: Parts List for this board is in Section VII.

Q.2 Function

The Frequency Control board is basically a control, metering, and status panel for the three frequency transmitter. It provides front panel control of the transmitter frequency, mode of operation, and other fine adjustments of transmitter tuning and loading. Status indicators are used for reporting of frequency mode and fault status, while multimeters indicate servo voltages required for tuning and loading.

Q.3 Location

The Frequency Control board is located behind the left front PA compartment door. (SEE VIEW 24)

Q.4 Block Diagram Description

Refer to Sheet 1 of the schematic for the Frequency Control board 839-7930-501 for the following discussion.

Q.4.1 Frequency Control Section

The Frequency Select Switches do not actually reside on the board. Their BCD outputs are connected from the 3F Controller to the board and passed as the Frequency Select Data for the Synthesizer Interface board. The BCD frequency information is encoded by the Frequency To Band Encoder PAL into Band Select Data for use on the Frequency Control Interface board for switching relays, and servo reference voltages.

Q.4.1.1 Normal Mode

The transmitter operates normally at the desired frequency with all transmitter power modes available for operation.

Q.4.1.2 Frequency Change Mode

In this mode the transmitter is interlocked off and all frequency adjustments are activated such as the frequency adjustment and servo controls.

Q.4.2 Indicator Logic

The mode control information and Frequency Control Fault inputs are connected to the LED Indicator Logic, which controls the Tune Mode Indicator LED Drivers and the Enables for the Fault Status Indicator LED Drivers.

The Tune Mode Indicator LED Drivers are used to illuminate the proper mode LEDs.

The Frequency Control Fault inputs are applied to the Fault Status Indicator LED Drivers and in conjunction with the Enables, allow these faults to be displayed when applicable.

Q.4.3 Meter Circuits

Two identical Multimeters are used for indicating the TUNE and LOAD servo parameters simultaneously during the tuning process. The two parameters measured are the servo Reference voltage and the servo Position Feedback voltage.

The Multimeter Switch Logic uses the mode information to Enable the LED Displays and to control the Multimeter Auto Switch that switches between the two servo samples. An additional function of the circuit is to switch the servo multimeters to the servo reference samples at any time.

The TUNE Multimeter may also be used along with the Multimeter Select Switch to measure Servo Supply Voltages and Drive Chain Meter Samples.

Q.4.4 TUNE And LOAD Servo Control

The Raise/Lower fine adjustments of the servos on the Frequency Control Interface board can be controlled by front panel center off toggle switches on this board.

Q.4.5 Power Supplies

+22VDC, -8VDC, and +8VDC are regulated down to +15VDC, -5VDC, and +5VDC respectively to power circuits on this board. The +5VDC supply is monitored by the Power Supply Fault Detector, which will generate a Supply Fault if the supply becomes defective.

Q.5 Detailed Circuit Description

Refer to the schematic diagram for the Frequency Control board (839-7930-501) for all descriptions in this section.

Q.5.1 Mode Control Section

In order to provide a means to change frequency both quickly and in as foolproof a manner as possible, modes of operation are switch selectable in order to provide the proper transmitter operation for the different phases of frequency change.

NOTE

The following is a description of what functions are active during the different modes of operation.

Q.5.2 Normal Mode

The transmitter operates normally at the desired frequency with all transmitter power modes available for operation.

Q.5.2.1 Frequency Control

No servo adjustments are active and the frequency and band information cannot be changed even if the front panel Frequency

WARNING: Disconnect primary power prior to servicing.

Selector switches are changed. The Antenna VSWR Null switches are active and can be used to null the front panel meter position if required.

Q.5.2.2 TUNE And LOAD Multimeters

The LOAD Multimeter is turned off.

If the Tune Meter Select switch is in the Normal position, the TUNE Multimeter is also turned off. If the Tune Meter Select switch is in the Multimeter position, the TUNE Multimeter is turned on and can measure up to 12 meter sample inputs.

Q.5.2.3 Fault Status

The TUNE and LOAD Servo Fault inputs are not active and the indicators on the front panel are extinguished.

The Frequency Synthesizer, Bandswitch Drivers, and Frequency Control Fault indicators should be illuminated GREEN. If any of these faults occur, the front panel indicator will turn RED, the TUNE and LOAD Multimeters will be turned on, and an RF MUTE will be applied to the transmitter.

Q.5.3 Frequency Change Mode

In this mode the transmitter is turned OFF and all frequency adjustments are activated.

Q.5.3.1 Frequency Control

The frequency entered into the Frequency Select switches will be latched into the Synthesizer when another mode is selected. It cannot be changed unless the frequency change mode is entered again.

The TUNE and LOAD Servo Raise/Lower controls are active. Each Servo Raise/Lower control switch will be adjusted using the appropriate Multimeter to a Servo Reference Voltage listed on the Transmitter Band Chart for the selected frequency.

The Antenna VSWR Null switches can be preset to values from the Transmitter Band Chart.

Q.5.3.2 TUNE And LOAD Multimeters

Both Multimeters will be turned on, and the Servo Reference Voltages will be displayed. Each Multimeter is used along with the Servo Raise/Lower controls to preset the appropriate Servo Reference Voltage listed on the Transmitter Band Chart for the selected frequency.

The TUNE Multimeter may be used as a Multimeter for checking meter sample inputs if desired.

Q.5.3.3 Fault Status

All Fault inputs are active, and each front panel indicator should be illuminated GREEN. If a fault occurs, the front panel indicator will turn RED and an RF MUTE will be applied to the transmitter.

Q.5.4 STATUS PAL

The purpose of STATUS PAL U3 is to display the mode of operation and depending upon that mode, control the multimeter functions and provide fault status indications.

Refer to Figure Q-1, STATUS PAL, for the following discussion.

Q.5.4.1 Mode Indicator Inverters

When the one of the mode inputs to the PAL is logic high, an inverter connected to an output pin of the PAL will be a logic low and illuminate the corresponding LED. Note that all indicators are YELLOW with the exception of the GREEN Normal Operation Mode LED.

Q.5.4.2 Tune Meter Select Switch

When the Tune Meter Select toggle switch S2 is in the Normal position, a logic high is supplied to U3-11. This input is connected to the MTR Norm output at U3-17, which causes the Tune Multimeter to monitor tune servo parameters depending upon the mode of operation. When S2 is in the M/M position, the logic low input/output signal causes the Tune Multimeter to switch to the Multimeter function, regardless of the mode selected.

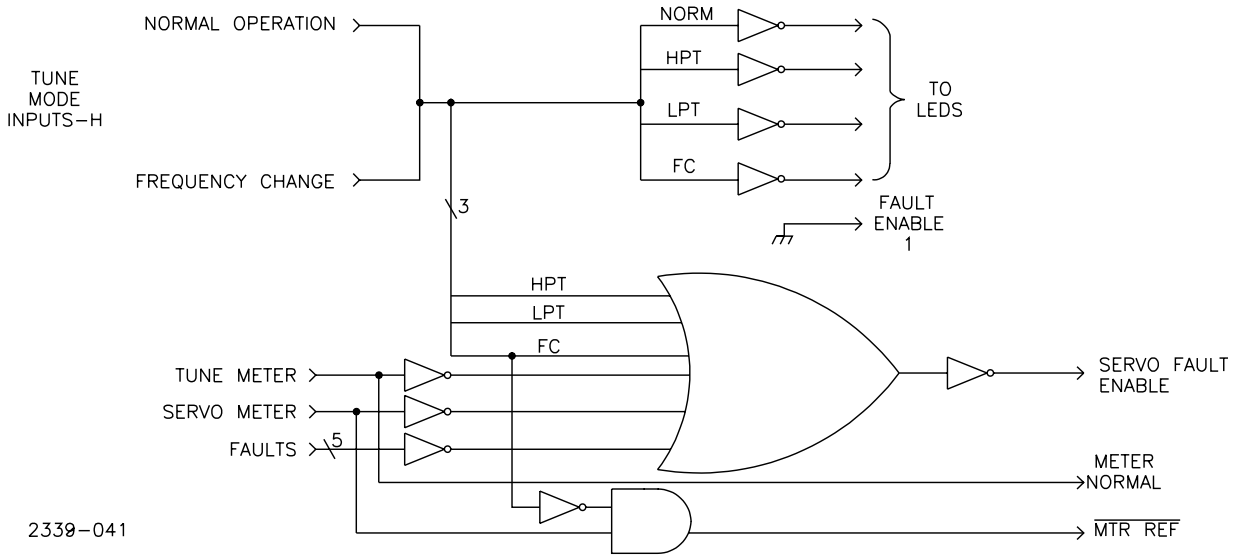

Figure Q-1. Status PAL

WARNING: Disconnect primary power prior to servicing.

Q.5.4.3 Servo Meter Select Switch

When the Servo Meter Select push-button switch S3 is in the Normal relaxed position, a logic high is supplied to U3-13. This input is connected to the MTR Ref output at U3-16, which causes the Tune and Load Multimeters to monitor tune servo parameters depending upon the mode of operation. When S2 is depressed to the Ref position, the logic low input/output signal causes the Tune and Load Multimeters to switch to the servo Reference voltage, regardless of the mode selected.

Q.5.4.4 Fault Inputs

All 5 of the fault inputs from J2 are connected to the input of the STATUS PAL. If any fault occurs, the input to the PAL will go logic low.

Q.5.4.5 Fault 1 Enable

U3-19 is internally connected to ground within the PAL, and this logic low output is connected to U4-19 and U5-1. It is used by the Fault Status Indicator circuit to provide the status of the Synthesizer, Bandswitch, and Power Supply fault inputs, regardless of the mode of operation.

Q.5.4.6 Servo Fault Enable

U3-18 is internally connected to the output of a inverter/multi-input OR gate within the PAL. The output is connected to U4-1 and depending upon the PAL inputs:

a. It is used by the Fault Status Indicator circuit to provide the status of the Tune and Load Servo fault inputs.
b. Turns on the LED Display Switch so that the Multimeter may be used.

When the following PAL input conditions are present, the Servo Fault Enable will be logic high:

a. Normal Operation mode
b. S2 and S3 in the Normal position
c. No Faults

When any of the following PAL input conditions is present, the Servo Fault Enable output will be logic low:

a. Frequency Change, Low Power Tune, or High Power Tune modes
b. S2 in the Multimeter position
c. S3 in the REF position
d. Any active Fault input

Q.5.5 Fault Status Indicators

The purpose of tri-state buffer U4 and octal buffer U5 is to control the 5 LED indicators that display the fault status.

Q.5.5.1 Synthesizer/Bandswitch/Supply Faults

These fault inputs are always displayed on the front panel in any mode. The Enable 1 from U3-19 is always active low and tri-state buffer U4 connects these inputs to the octal inverter U5. The fault input is normally logic high, and the input to inverter and the anode of the GREEN LED's also logic high. The inverted output that is connected to the cathode of the GREEN LED is logic low and the LED is illuminated GREEN. When the fault input goes logic low, the voltages reverse and the RED LED is illuminated.

Q.5.5.2 TUNE And LOAD Servo Faults

These fault inputs are only displayed on the front panel when the Servo Fault Enable from U3-18 is active low. Tri-state buffer U4 connects these inputs to the octal inverter U5. The fault input is normally logic high, and the input to inverter and the anode of the GREEN LED's also logic high. The inverted output that is connected to the cathode of the GREEN LED is logic low and the LED is illuminated GREEN. When the fault input goes logic low, the voltages reverse and the RED LED is illuminated.

When U3-18 is a logic high the output pins of the tri-state buffer are disconnected. The faults are not active and the neither LED is illuminated.

Q.5.6 LED Display Switch

Transistor Q1 controls the +5VA supply to the Multimeter LED Displays.

When the Servo Fault Enable output goes logic low, this enables U4-14 which supplies a ground for the voltage divider that turns on Q1. The +5VDC supply is connected to the +5VA supply for the Display LED's through Q1, and the Multimeters are turned on.

Q.5.7 Frequency To Band Encoder

The Frequency to Band Encoder takes the BCD transmitter frequency information and encodes it into a 6 Bit Binary output that divides the operating frequency range into 64 bands.

Q.5.7.1 Frequency Select Switch Inputs

The 4-4 Bit BCD active high inputs from the front panel Frequency Select switches S13 enter the board on J4 and J5. All 16 BCD inputs are directly connected to the Synthesizer Interface board at J3, which is used to program the Synthesizer operating frequency.

Q.5.7.2 BAND ENC PAL

The Frequency to Band Encoder PAL U6 uses the 3 most significant BCD inputs from the Frequency Select Switches to produce the 6 Bit Band Select Data Outputs.

Refer to Figure Q-2, ENCODER PAL, for the following discussion.

The program for the PAL basically divides the transmitter frequency range of 525 kHz to 1605 kHz into 64 bands, each of which is 20 kHz wide.

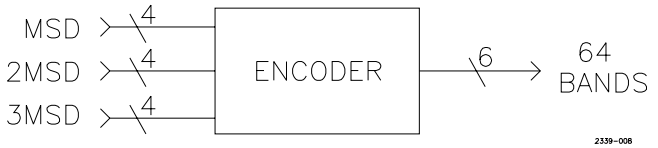

Figure Q-2. Encoder PAL

WARNING: Disconnect primary power prior to servicing.

If a frequency of 936 kHz was entered on the front panel, the transmitter will be in Band 40, and the 6 Bit outputs from the BAND ENC PAL will be as seen below.

BCD INPUT		6 BIT OUTPUT		BAND 0
MSD1	1			
MSD2	0			
MSD4	0			
MSD8	0	Bit 5	1	MSB
2MSD1	0	Bit 4	0	
2MSD2	1	Bit 3	1	
2MSD4	1	Bit 2	0	
2MSD8	0	Bit 1	0	
3MSD1	0	Bit 0	0	LSB
3MSD2	0			
3MSD4	0			
3MSD8	0			

If a frequency of 585 kHz was entered on the front panel, the transmitter will be in Band 60, and all 6 Bit outputs from the BAND ENC PAL will be logic high.

BCD INPUT		6 BIT OUTPUT		BAND 0
MSD1	0			
MSD2	0			
MSD4	0			
MSD8	0	Bit 5	1	MSB
2MSD1	1	Bit 4	1	
2MSD2	0	Bit 3	1	
2MSD4	1	Bit 2	1	
2MSD8	0	Bit 1	0	
3MSD1	0	Bit 0	0	LSB
3MSD2	0			
3MSD4	0			
3MSD8	1			

NOTE

Refer to the Transmitter Band Chart, for the following example.

If operating at a Transmitter Frequency of 684 kHz, the chart shows that the Frequency Band is 54. By converting this decimal number back to its binary equivalent, the logic levels of the BAND ENC PAL outputs may be determined.

OUTPUT	LOGIC LEVEL	DECIMAL EQUIVALENT
Bit 5	1	32
Bit 4	1	16
Bit 3	0	8
Bit 2	1	4
Bit 1	1	2
Bit 0	0	1
		54

This Band Select Data is connected to the Frequency Control Interface board at J1, and is used to encode into the proper outputs for each bandswitched component.

Q.5.8 TUNE And LOAD Multimeters

The Frequency Control board has two identical Multimeters used for indicating the loading and tuning servo parameters simultaneously for use in the tuning process. The two parameters measured are the servo reference voltage used for presetting the servo during the Frequency Change mode and the servo feedback voltage used to monitor the actual location of the servo during the fine tuning adjustments. The TUNE Multimeter may also be used as a Multimeter is measure other voltages.

Q.5.9 Multimeters

Multimeters U9 and U10, are 3 1/2 digit multimeters with LED readouts. In this application, the meter is fixed reading of 2 digits in the mantissa and 1 digit for decimal indication. A display of the polarity is automatically provided.

Q.5.9.1 Supply Voltages

Each Multimeter requires +5VDC and -5VDC power supplies, and a +2.00VDC reference voltage. These references are developed by adjustable voltage dividers R27 and R36 which may be measured at TP1 and TP2.

Q.5.9.2 Multimeter Inputs

The input to U9 is connected to K1-8 and the input to U10 is connected to U8-4, both part of the Multimeter Autoswitch. The actual DC voltage at either of these two inputs, will be the voltage that the Multimeter will display when activated.

Q.5.9.3 Lamp Test

The Lamp Test Function is used to verity that all LED displays are functional. When JP1 is jumpered 2-3, both Multimeters should display -88.8.

Q.5.9.4 LED +5VA Voltage

The LED displays only become activated when the Servo Fault Enable from the STATUS PAL goes logic low. The +5VA supply is activated by the LED Display Switch, the Multimeters are illuminated and may be used.

Q.5.10 Multimeter Autoswitch

It is necessary to monitor the servo reference voltage during the Frequency Change mode in order to preset the reference voltage. It is necessary to monitor the servo feedback voltage during fine tuning. The purpose of this circuit is therefore to switch the desired sample depending upon the mode selected.

Q.5.10.1 Meter Sample Inputs

The servo voltage meter samples enter on J1 and are connected to analog switch U8. The Multimeter samples enter on J2 and are connected to S7.

Q.5.10.2 Analog Switch

Analog switch U8 is shown with S3 in the Servo Meter Normal position and in either the Low or High Power Tune mode. The B and C inputs at U8-10 and U8-9 will be logic low, and the switches are in the position drawn.

The TUNE Position meter sample passes from U8-2 to U8-15 and then through K1-2 to K1-8 and is connected to the input of the TUNE Multimeter.

The LOAD Position meter sample passes from U8-5 to U8-4 and is then connected to the input of the LOAD Multimeter.

When in the Frequency Change mode or if the Servo Meter Reference is selected by S3, the B and C inputs are a logic high, and each Multimeter input is switched to the Reference meter sample.

WARNING: Disconnect primary power prior to servicing.

Q.5.11 TUNE Multimeter

Since the multimeter is a full range meter, the TUNE Multimeter also provides a second function as a Multimeter for other meter samples.

Q.5.11.1 Relay Switch

Relay switch K1 is shown with S2 in the Tune Meter Normal position. Transistor Q2 is cutoff, K1 is de-energized, and the contacts are in the position drawn.

When the TUNE Meter Multimeter is selected by S2, transistor Q2 is saturated and K1 is energized. The TUNE Multimeter input is switched to the output of S7, and the Decimal Point of the TUNE Multimeter is connected to a timer.

Q.5.11.2 Multimeter Select Switch

S7 is a multi-position switch that is used to select one of 12 inputs to be measured by the Multimeter. When switched to the EXT Meter position, any voltage under 70VDC may be connected to TP11 and measured on the Multimeter.

Q.5.11.3 Decimal Point Timer

To avoid operator confusion, when K1 is energized the Decimal Point input of U9 is connected to the output of timer U16. The flashing Decimal Point is an indication that the Tune Multimeter is in the Multimeter function.

Q.5.12 Power Supplies

DC supply inputs to the board are +22VDC, +8VDC, and -8VDC, from the low voltage power supply. Each input is fused, with 2A fuses F1, F2 and F3, and regulated to +15VDC, +5VDC and -5VDC using regulators U12, U13,and U14. All supplies have a green Status LED that lights when the regulator is operational. The output of these regulators are transient protected by transzorbs.

Q.5.12.1 Regulator Status

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +22VDC supply goes to CR8 and CR9 and +8VDC goes through CR1 to a 5 Volt regulator, U11. This +5 Volts is designated +5VB and can be measured at TP10.

The +5VB is used as the reference to inputs of comparator U15 through a series voltage divider network. Each supply is connected to a voltage divider and then connected to the other inputs of U15. With the non-inverting inputs more positive than the inverting inputs the outputs of U15 are at logic high. This is the NORMAL condition with no faults.

The +15VDC and -5VDC supplies are used for the multimeter circuit only.

If one of the regulated supplies fails or drops too low, the corresponding comparator output will go logic low and illuminate DS17 +15/-5V Supply Fault RED. No additional transmitter action is performed since these are non critical supplies.

The main +5VDC supply comparator output is connected the + input of a second comparator and DS16. If the supply drops too low, the comparator output will go logic low and illuminate the +5V Supply Fault RED. This will cause the output of U15-1 to go logic low and generate a Supply Fault at J2-9. It is sent to the Frequency Control Interface board and will generate an RF MUTE.

Q.6 Troubleshooting

The following information contains general troubleshooting tips and any precautions if applicable.

Faults on this board may be classified into:

a. Frequency Control
b. Metering
c. Power Supplies

Q.6.1 Frequency Control

a. If frequency related faults occur, such as Frequency Synthesizer, go to the Frequency Change mode:
b. Select F1 on the front panel. Check the logic level of all BCD inputs at J3 and all 6 Bit Binary outputs at J1. They should match the data shown in the chart as described above.
c. Select F2 on the front panel. Check the logic level of all BCD inputs at J3 and all 6 Bit Binary outputs at J1. They should match the data shown in the chart as described above.
    1. If the BCD inputs are incorrect, check 3F Controller switches.
    2. If the 6 Bit Binary output is incorrect, replace the BAND ENC PAL.

Q.6.2 Metering

a. If both Multimeters fail to turn on, check the +5VA supply.
    1. If no +5VA supply, check Q1, U4, and the STATUS PAL.
b. If the Multimeter readings do not switch between Reference and Position voltages:
c. Check the U8 switch control voltage, it should show a logic low for Position, and a logic high for Reference voltage.
    1. If the voltages are correct, suspect U8.
    2. If the voltages are not correct, suspect the STATUS PAL.
d. If the Multimeters are operational, but give the wrong measurements:
    1. Check the +2.00VDC, +5VDC, and -5VDC supplies.
    2. Use the Lamp Test to test all LED display segments.

Q.6.3 Power Supply

a. If DS17 is illuminated RED:
b. Use the Multimeter to measure the +15VDC and -5VDC power supplies.
c. If either supply has been reduced to less then 80% of normal:
    1. Check the input fuse and replace if necessary.

WARNING: Disconnect primary power prior to servicing.

2. If fuse is not open, measure input TP for the unregulated voltage.
3. If the unregulated input is correct, replace the regulator.

d. If DS16 is illuminated RED:

e. Use the Multimeter to measure the +5VDC power supply.

f. If the supply has been reduced to less than 80% of normal:
   1. Check the input fuse and replace if necessary.
   2. If the fuse is not open, measure input TP for the unregulated voltage.
   3. If the unregulated input is correct, replace the regulator.

g. If all supplies measure correct:
   1. Check TP10 for +5VDC and replace U11 if necessary.
   2. If TP10 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

Q.7 Removal\Replacement

With the low voltage power supplies shut off, remove the allen screws from the front panel knob and pull it straight out. Remove all connectors and top outside mounting screws.

When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches are set to the same position as the original board.

When installing a new board, verify that all jumpers are in the same position as the original board.

Q.8 Alignment

Verify that the voltages at TP1 and TP2 are +2.00VDC. If they are not, adjust R27 for TP1 and R36 for TP2.

WARNING: Disconnect primary power prior to servicing.

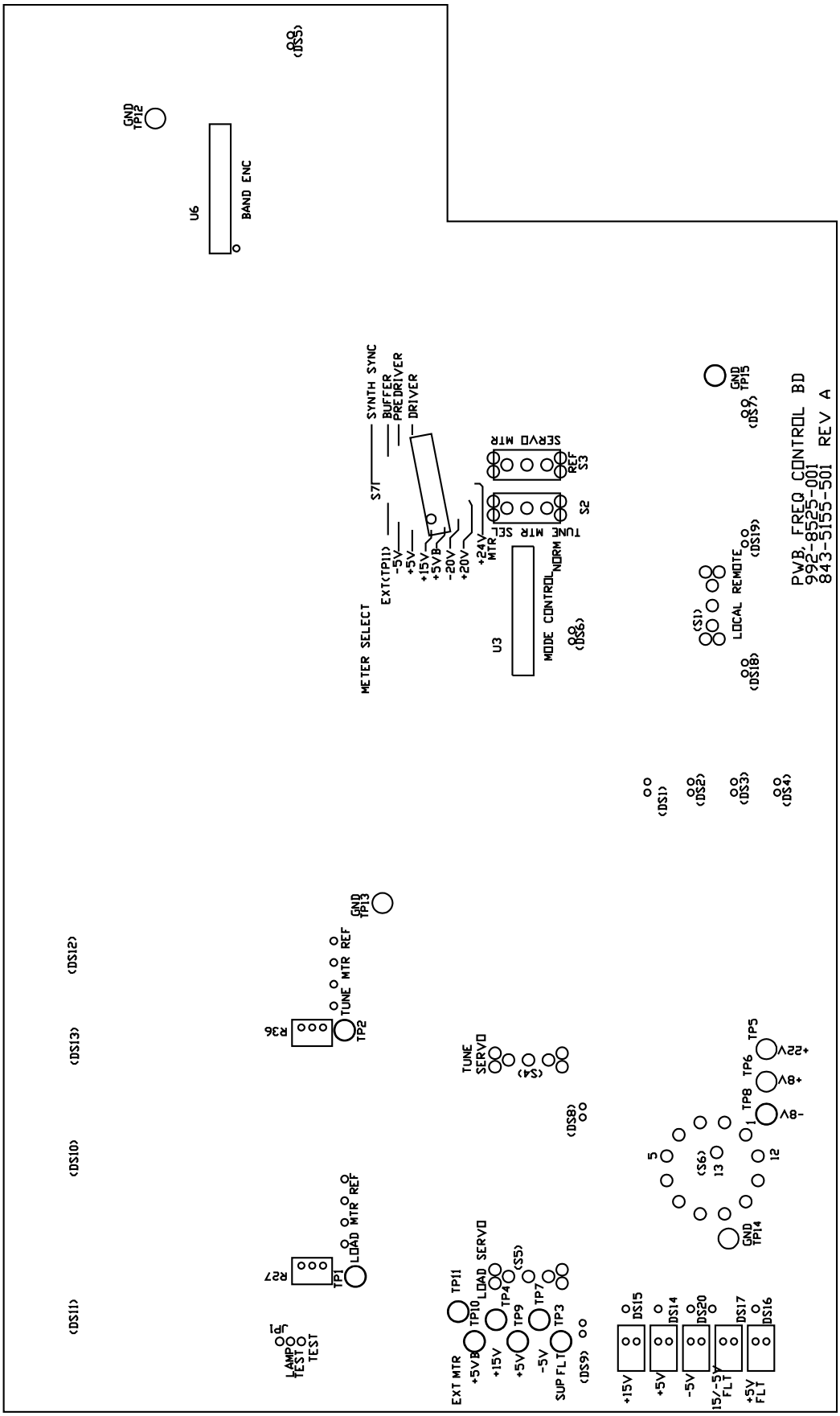

Figure Q-3. Frequency Control Board Controls and Indicators

WARNING: Disconnect primary power prior to servicing.

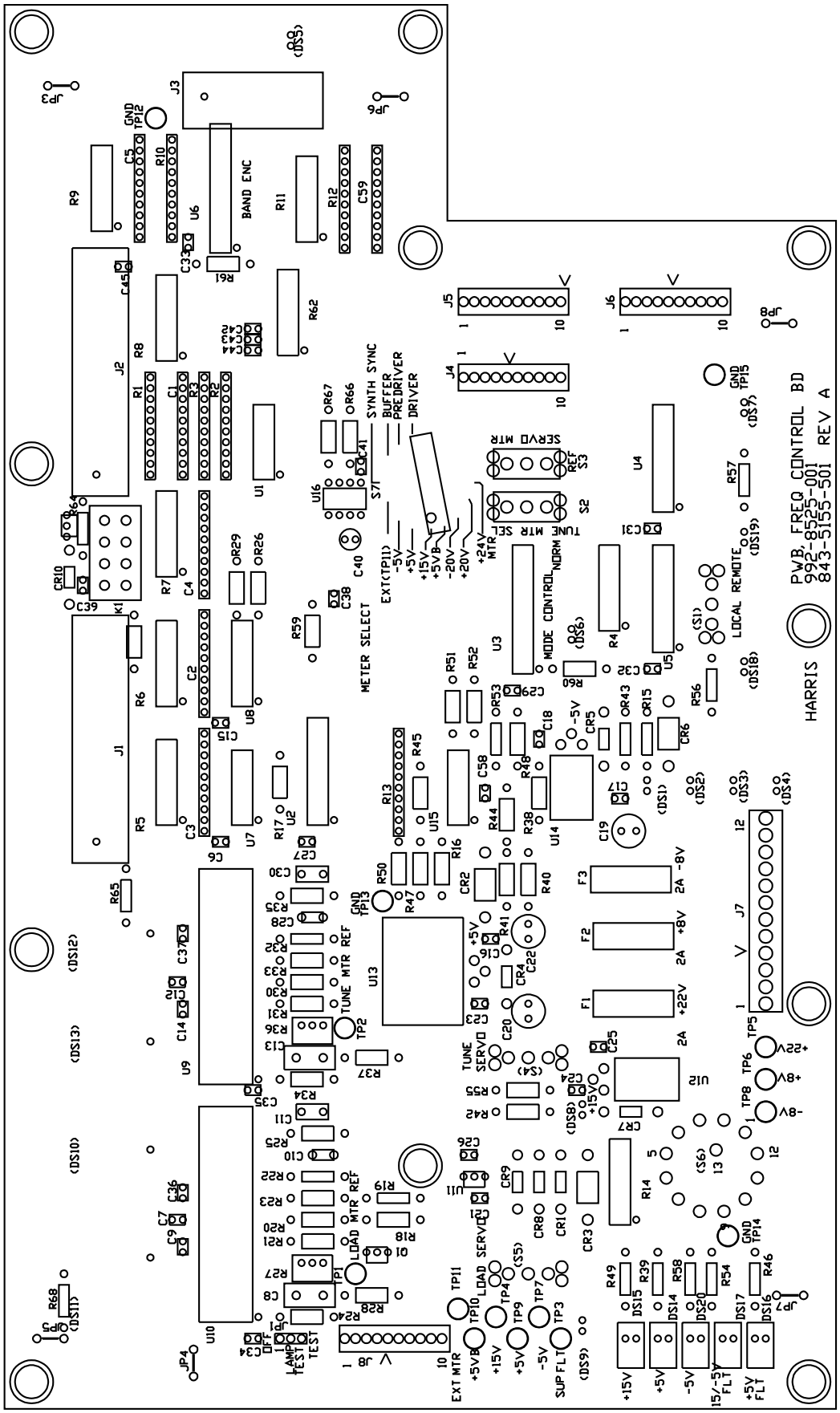

Figure Q-4. Frequency Control Board Component Locator

WARNING: Disconnect primary power prior to servicing.

R.1 Introduction

This section covers the Frequency Synthesizer Interface board. Topics include function, location, block diagram description, detailed circuit description, troubleshooting, and removal/replacement, and alignment.

NOTE: Parts List for this board is in Section VII.

R.2 Function

The function of the Frequency Control Interface board is to take the Band Select Data and use this information to switch the appropriate components for the desired frequency. This board performs both binary weighted switching of relays and servo controlled adjustment of the tuning and loading of the transmitter for fine tuning. Also on this board is the fault circuitry for protecting the transmitter in case of a bandswitch or servo fault along with the required control logic for operating the transmitter during frequency change and subsequent tune up.

R.3 Location

The Frequency Control Interface board is located inside the right front PA compartment on the upper left hand side. (SEE VIEW 14)

R.4 Block Diagram Description

Refer to Sheet 1 of the schematic for the Frequency Control Interface board 839-7930-502 for the following discussion.

For more detailed drawing information, refer to the Simplified Overall Block Diagram 843-5155-550.

R.4.1 Band Select Data Latch

The 6 Bit Binary Band Select Data information from the Frequency Control Board, is passed on to the Band Select Data Latch.

R.4.2 Bandswitched Circuits

The following circuits require switching of some type of reactance to track the operating frequency. A basic description of what is required to change is included for reference.

R.4.2.1 Synthesizer SYNC Band Encoder

The output of the Band Encoder is a Synthesizer SYNC Data signal to drive a programmable delay device on the Frequency Synthesizer Interface board.

R.4.2.2 Driver Encoder Band Encoder

The output of the Encoder is used to encode the A/D Phasing, A/D Frequency, and Driver Level signals for the Driver Encoder board.

R.4.2.3 Predriver/Driver Band Encoder And Relay Drivers

The output of the Encoder And Relay Drivers is used to encode the Predriver Tune, Driver Tune, and Predriver Level outputs for the Predriver Tuning Board and the Driver Tuning assembly.

R.4.2.4 Efficiency Coils/2L1/1C1/2C5 Band Encoder And Relay Drivers

The output of the Encoder And Relay Drivers is used to encode the outputs for the Efficiency Coils boards, the large series tuned inductor in the Output Network, the series capacitance at the ground end of the combiner, and the shunt capacitor at the input of the Output Network.

R.4.2.5 2C2 Band Encoder

The output of the Encoder And Relay Drivers is used to encode the output for the large shunt matching capacitor in the Output Network.

R.4.2.6 2C3/2C4 Band Encoder

The output of the Encoder And Relay Drivers is used to encode the output for tuning the 3rd harmonic trap and the output shunt capacitor.

The Osc Drive Phasing Drive is not used in this application.

R.4.2.7 Antenna/Network VSWR Band Encoder

The output of the Encoder And Relay Drivers is used to switch components on the Output Monitor VSWR Detectors.

The External Adjustment input is used for nulling the Antenna VSWR Detector in single transmitter applications.

R.4.3 Servo Circuits

The main purpose of the Servo circuits is to allow the output tuning and loading to be quickly adjusted to the optimum point for each given frequency using a front panel electrical control. The Servo circuit requires a reference voltage which is used to tell the servo what position is required. The Position voltage is feedback from a potentiometer mechanically connected to the servo mechanism. When the servo is activated, the Servo will always try to make the position voltage from the feedback pot the same as the reference voltage. The Tune and Load circuits function in the same manner.

R.4.3.1 Reference Counter/Reference Digital Pot

The function of the Reference Digital Pot is to develop a reference voltage that can be varied in increments as a function of the particular band chosen. The Reference Counter is used to provide Raise/Lower adjustment of the reference voltage as needed during fine tuning. The Reference Digital Pot works in conjunction with the Reference Counter to provide full range and fine range adjustments.

WARNING: Disconnect primary power prior to servicing.

R.4.3.2 Servo Amp

The Servo Amp is a single device that will compare the reference voltage with the Servo Feedback Position voltage. If there is a difference in the two voltages, the Servo Amp will produce sufficient Motor Output Drive current to drive the servo motor to the correct position.

R.4.3.3 Servo Fault Detector

This circuit will compare the Reference voltage with the Position voltage and produce a Fault output if the two voltages are not within an acceptable range. These two voltages are metered on the Frequency Control board.

R.4.3.4 Servo Control Logic

The Servo Logic circuitry is responsible for turning on/off the servo circuits and the Servo Power Supply Relay when the transmitter is in the proper mode.

R.4.3.5 Servo Power Supply Regulators

Regulators use unregulated + and - 20VDC from the Servo Power Supply to generate the Servo Regulated + and - 15VDC for the Servo Amplifiers.

R.4.4 Transmitter Control/Fault Logic

R.4.4.1 Control Logic

The function of this circuit is to change the Transmitter Control Outputs (OFF, LOW, HIGH, RF MUTE) to the Transmitter Interface, depending upon the input Tune Mode Data. It also takes the External Clock and provides a Band Latch clock to the Band Select Data Latch when in the Frequency Change Mode.

R.4.4.2 Fault Logic

The Fault Logic monitors the Tune, Load, Synthesizer, Bandswitch (which could be Efficiency Coil Cable Interlock or loss of +24VDC), and Power Supply (which could be on-board or from the Frequency Control board). The Frequency Control Fault Status outputs to the Frequency Control board provides an indication when a fault occurs in the frequency change circuitry.

R.4.5 Power Supplies

+22VDC, +8VDC, and -22VDC is regulated down to +15VDC, +5VDC, and -15VDC respectively to power circuits on this board. The supplies are monitored by the Power Supply Fault Detector, which will generate a Supply Fault if the supply becomes defective.

The +24VDC Unregulated Relay Supply input is connected to the Band Switch Drivers via the Driver Fuses. Part of the Bandswitch Fault Detector monitors the Driver fuses and can generate this fault if required.

R.4.6 Meter Interface

This board connects the SYNTH SYNC, Buffer, Predriver, and Driver meter samples to the Frequency Control board.

R.5 Detailed Circuit Description

Refer to the schematic diagram for the Frequency Control Interface board (839-7930-502) for all descriptions in this section.

R.5.1 Power Supplies

DC supply inputs to the board are +22VDC, +8VDC, and -22VDC, from the low voltage power supply. Each input is fused, with 2A fuses F11, F9 and F10, and regulated to +15VDC, +5VDC, and -15VDC using regulators U37, U35, and U36. Each regulator output has a GREEN Status LED that illuminates when the regulator is operational. The outputs of the regulators are transient protected by zeners CR20, CR18, and CR19.

R.5.1.1 Power Supply Fault Sensing

In order to be able to have an on-board visual status indication of regulator operation, it is necessary to have a supply voltage on the board that does not depend on the regulated supplies. The +22VDC supply goes to CR14 and CR13 and the +8VDC goes through CR12 to a 5 Volt regulator, U38. This +5 Volts is designated +5VB and can be measured at TP29.

The +5VB is used as a reference to inputs of comparator U39 through a series voltage divider network. Each supply is connected to a voltage divider and then connected to the other inputs of the comparator. With the non-inverting inputs more positive than the inverting inputs the comparator output is a logic high. This is the NORMAL condition with no faults.

If one of the regulated supplies fails or drops to less than 80% of normal, the corresponding comparator output will go logic low. DS3 Supply Fault will be illuminated RED and the voltage at J3-3 will be logic low.

This will cause the transmitter to apply an RF Mute, and the Supply Fault LED on the Frequency Control front panel will be illuminated RED.

R.5.1.2 Servo/Relay Supplies

Unregulated +24VDC, +20VDC, and -20VDC power supply inputs enter the board at J12. Each input is fused and has a green status indicator along with a meter sample resistor.

R.5.1.3 Battery Backup

+5VDC from the Transmitter Interface board enters at J18 and is designated +5VC. It is used as the power supply for circuits that require memory when the transmitter has lost A/C power. This voltage may be measured at TP7 and is also connected to the Frequency Control board at J20.

R.5.2 Band Select Latch

The 6 Bit Binary 64 Band information that is encoded on the Frequency Control Board is connected to this board at J19. The Band information is passed on to the Band Select Data Latch U6. When in the Frequency Change Mode, the Band Latch Clock input is active and the Band information is allowed to switch components. When in any of the other modes, the last clocked input remains at the output of the Latch. The output latched Band information is passed to several PALs for complete switching functions.

WARNING: Disconnect primary power prior to servicing.

R.5.3 Transmitter Control/Fault Logic PAL

The function of this PAL is to control the transmitter mode depending on the frequency control mode. The transmitter should be shut OFF when the frequency is changed and major component values are switched. The transmitter must be operated at LOW and HIGH power during the initial tune up stage in changing frequency. The fault logic section also determines what action to take when a fault occurs in the frequency change circuitry.

Refer to Figure R-1, TX CTRL/FLT PAL, for the following discussion.

R.5.3.1 Control Inputs

The inputs to the PAL are the active high Tune Mode Data from the Frequency Control board at J19, the internal 12.5Hz Control Clock, and the logic high Auto Tx Power Control input from JP4. Note that the Normal Mode input does not connect to the PAL.

R.5.3.2 Control Outputs

All control outputs of the PAL are active high, and inverters present open collector active low signals to the Transmitter Interface board at J18.

R.5.3.2.1 Frequency Change Mode

When the Frequency Change input goes logic high, simultaneously the RF MUTE and TX OFF outputs of the PAL also go logic high and the transmitter is shut OFF. The 12.5 kHz Clock is connected to the Band Latch Pulse Generator, which will generate a 100mS Band Latch Pulse output (after a delay) at TP2 when both entering or exiting the Frequency Change mode. This pulse will allow new Frequency Band Data to be latched by U6. This Band Latch output is also used by the Frequency Synthesizer Interface at J17 and the Frequency Control board at J19.

R.5.3.3 Fault Inputs

Internal fault inputs to the PAL are Bandswitch, Power Supply, Efficiency Coil, Tune, and Load. External fault input are Synthesizer at J17 and Frequency Control Power Supply at J20. All fault inputs are active low, except for Bandswitch and Efficiency Coil faults which are active high.

R.5.3.4 Fault Outputs

When any fault input goes active low, the PAL will produce an RF MUTE and the power output will drop to 0kW to protect the transmitter.

The 5 active low fault outputs are connected to the Frequency Control board at J20 for illuminating the corresponding frequency control front panel LED indicator RED. Note that a Bandswitch Fault could either be a Bandswitch or Efficiency Coil Fault and a Power Supply Fault could be for either the Frequency Control board or the Frequency Control Interface board.

R.5.4 Band Switch Encoding

To optimize the frequency tuning process, the bandswitching is done in binary fashion. This will produce a fairly flat response with frequency.

To allow the 6 Bit input Band Select Data to switch the resultant circuit at the proper point, a Band Encoder is used to encode the 6 bit input band into the desired output band whether it is a 1 to 6 bit output.

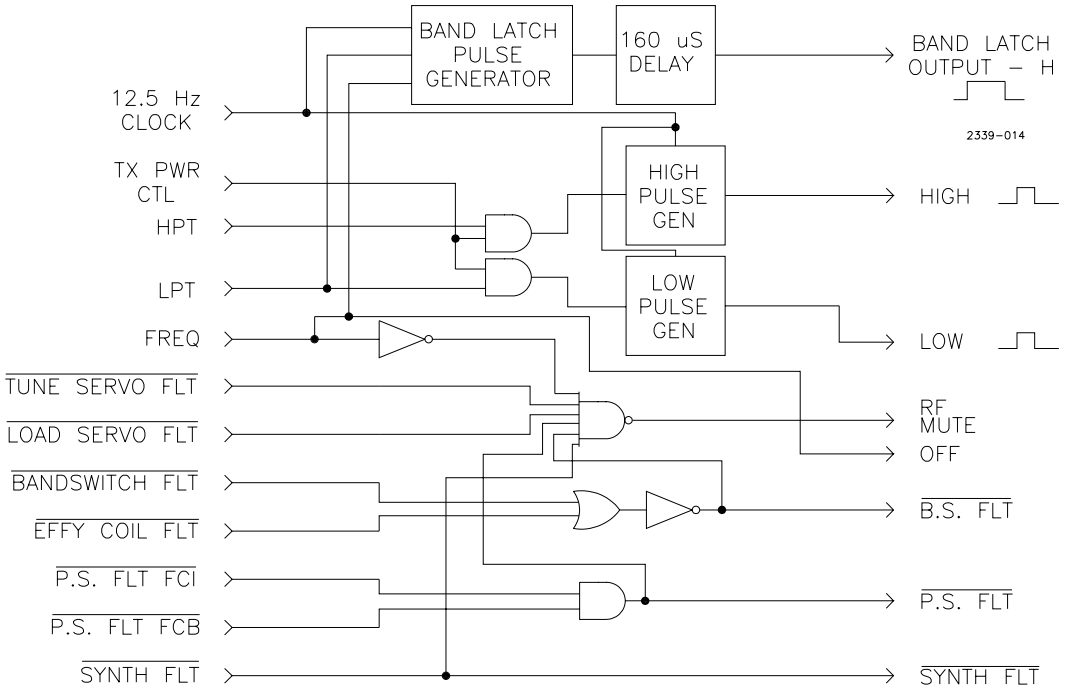

Figure R-1. TX CTRL/FLT PAL

WARNING: Disconnect primary power prior to servicing.

To do this a programmable device PAL is used for flexibility. This programmable device can therefore be changed easily without circuit board changes.

R.5.5 Relay Encoding Example

NOTE

Refer to the Transmitter Band Chart, for the following examples.

Refer to Figure R-1 PAL Encoder for the following example.

For example, if the Frequency Band is 36 (1000 kHz transmitter frequency) and the Encoder is for the Driver Relay Drive, the Driver Band is 17. The output of the Encoder will be as follows:

OUTPUT	ENC OUT	DEC EQUIV		PAL OUTPUT
Bit 5	0	32		1
Bit 4	1	16	16	0
Bit 3	0	8		1
Bit 2	0	4		1
Bit 1	0	2		1
Bit 0	1	1	1	0
	BAND	=	17	

Since this Encoder is for Relay Drivers, all 6 outputs from the Encoder are connected to the PAL output via inverters.

R.5.5.1 Relay Drivers

When the PAL output is logic high, the open collector relay driver output at J21 will be +24VDC. The relay connected to the output will be de-energized.

When the PAL output is logic low, the open collector relay driver output will be connected to ground. The relay connected to the output will be energized.

R.5.6 Active High Output Encoding Example

For example, if the Frequency Band is 36 (1000 kHz transmitter frequency) and the Encoder is for the Synthesizer Sync, the Band is 50. The output of the Encoder will be as follows:

OUTPUT	ENC OUT	DEC EQUIV		PAL OUTPUT
Bit 5	1	32	32	1
Bit 4	1	16	16	1
Bit 3	0	8		0
Bit 2	0	4		0
Bit 1	1	2	2	1
Bit 0	0	1		0
	BAND	=	50	

Since this Encoder is a Active High Output, the PAL outputs will be the same as the Encoder Outputs.

R.5.7 Bandswitched Circuits

The following circuits require switching of some type of reactance to track the operating frequency. A description of what is required to change is included in this section, refer to the Output Network Schematic 843-5155-553 and the Power Amplifier Schematic 843-5155-551 for the following discussion.

R.5.8 COMBINER PAL

The COMBINER PAL receives the Band Select Data and encodes the outputs for the Efficiency Coil boards, 1C1, 2L1, and 2C5.

R.5.8.1 Efficiency Coil Band Switching

For optimum transmitter efficiency, the efficiency coils must be switched at various transmitter bands. This 2 bit system basically switches two relays in binary fashion to achieve the four inductance values. Each relay is a DPDT type and two contacts are switched at once.

Refer to Sheet 1 of the schematic for the Efficiency Coil board 839-7930-503 for the following discussion.

R.5.8.2 Efficiency Coil Relay Drivers

There are 20 Efficiency Coil boards located in the Left, Center, and Right Compartments and on the Driver Section. Each Efficiency Coil has 8 relays on the board.

All the odd number relays of the Efficiency Coil boards are connected to the B0 MOSFET switch Q2 at J3 through J6. All the even number relays of the Efficiency Coil boards are connected to the B1 MOSFET switch Q2 at J3 through J6.

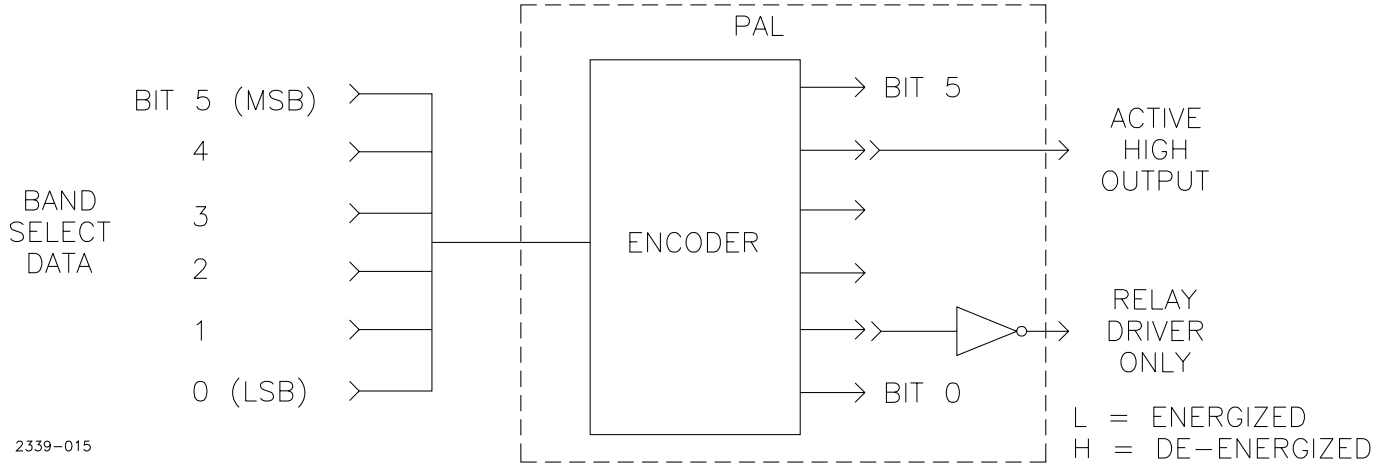

Figure R-2. PAL Encoder

WARNING: Disconnect primary power prior to servicing.

When the Bit output of the PAL is logic high, the corresponding MOSFET switch is turned on and the relay will be energized.

NOTE

The Truth Table on the schematic lists the Turns In Use per each Band.

R.5.8.3 1C1 Band Switching

The series capacitance at the ground end of the combiner is used to resonate with the combiner inductance to reduce the peak voltage on the combiner pipe. Capacitors C2, C3, C49 and C50 are in parallel with a group of 5 fixed capacitors. The total capacitance value is changed in 3 bands by three relays K2 (Bit 1), K3 (Bit 1) and K4(Bit 0).

The relay driver outputs are at J21.

R.5.8.4 2L1 Band Switching

The large series tuned inductor in the output network is band-switched to allow the series variable capacitor 2C1 to be in range for the entire frequency range. Motor Drive Assemblies 2A8 (Bit 1) and 2A9 (Bit 0) are used to short out unused turns of the coil depending on the 3 bands.

R.5.8.4.1 Inductor Switch Assemblies

When the outputs of the PAL are both logic low, both shorting contacts of S5 and S6 will be away from the coil, using the full inductance. When S5 is closed, 5 turns of the coil are shorted out. When S6 is closed, 3 turns of the coil are shorted out.

The Inductor Switch outputs are at J7.

R.5.8.5 2C5 Band Switching

A small value of capacitance 2C5 is switched in by a vacuum relay K5 at the output of the combiner. This shifts the resonance of the combiner at a few frequencies where the combiner may go resonant at a harmonic of the carrier frequency. Only B0 is used to control this 2 band circuit. The relay driver output is at J7.

R.5.9 2C3/2C4 PAL

The 2C3/2C4 PAL receives the Band Data and encodes the outputs for the 2C3 and 2C4.

NOTE

The External Phase Adjustment B0 through B5 are not being used by the PAL in this application.

R.5.9.1 2C4 Band Switching

2C4 is the output Pi matching shunt capacitance. It is used in conjunction with the transmitter loading to match antenna impedances. This 4 Bit system basically switches four vacuum relays K4C through K4F in binary fashion to achieve the desired value in 15 bands. The relay driver outputs are at J10.

R.5.9.2 2C3 Band Switching

A small value of capacitance C3B is switched in a single band by vacuum relay K3B, to allow the variable capacitor 2C3 to trap out the third harmonic for the entire frequency range. Only B0 is used to control this 2 band circuit. The relay driver output is at J10.

R.5.10 2C2 PAL

2C2 is the shunt capacitance in the input of the Pi matching network. This 5 bit system basically switches six vacuum relays K2E through K2N in binary fashion to achieve the desired value in 26 bands. The relay driver outputs are at J8.

NOTE

There are two relays connected to the bit 4 output.

R.5.11 SYNTH PAL

For optimum VSWR protection the Synthesizer Interface output must be synced to the combiner current during a VSWR fault condition. This sync signal must be optimized for each frequency. This circuit basically involves changing the delay of the combiner sample such that the oscillator and combiner sample are in phase. This output is a TTL active high logic 6 bit signal that divides the range into 58 bands. The output to the Frequency control Interface board at J17.

R.5.12 PREDRIVER PAL

The PREDRIVER PAL receives the Band Data and encodes the outputs for the Predriver tuning components and the Predriver level.

R.5.12.1 Predriver Tuning

The Predriver is tuned by a binary combination of inductance and Capacitance that is switched by relays on the Predriver Tuning board. The Predriver tuning is a 5 bit signal for frequency tuning in 31 bands. The relay outputs are at J1.

R.5.12.2 Predriver Level

The Bit 0 output is a 2 band output for switching the series resistance in the power supply line for optimum Predriver output level.

R.5.13 A/D PAL

The A/D PAL receives the Band Data and encodes the outputs for the A/D Phase, A/D Frequency, and Driver Level on the Driver Encoder at J16.

R.5.13.1 A/D Phase

The transmitter A/D phasing is also frequency dependant and must be optimized for each frequency. This circuit basically involves changing the delay of the A/D sample frequency such that the RF Amplifier switches at the optimum time. This output is a TTL logic 6 bit signal to drive a programmable delay device in 63 bands.

R.5.13.2 A/D Frequency

Also required is the ability to switch the A/D sample frequency from the same as the carrier frequency (below Fc of 1 MHz) to 1/2 of the carrier frequency when the transmitter carrier is over 1 MHz. When the output is logic low, the sample frequency will equal the transmitter frequency.

R.5.13.3 Driver Level

The Driver Level output is used to control the frequency determined Drivers on the Driver Combiner Motherboard. This is a 2 bit active high output that breaks the frequency range into 4 bands.

R.5.14 DRIVER PAL

The DRIVER PAL receives the Band Data and encodes the outputs for the Driver Tuning Assembly and the Driver Level toroid, at J2.

R.5.14.1 Driver Tuning

The Driver Combiner pipe is tuned to series resonance by the Driver Tuning Assembly. A binary combination of inductor L1 through L6 and capacitors C1 though C6 are switched by vacuum relays K1 through K5. The Driver tuning is a 5 bit signal that breaks the frequency range into 31 bands.

R.5.14.2 Driver Level

The Bit 0 output is a 2 band output for switching the toroid T1 via K1 into the boost (de-energized)/no boost (energized) connections.

R.5.15 Servo Circuit Descriptions

The main purpose of the servo drive circuits is to allow the PA tuning and loading to be quickly adjusted to the optimum point for each given frequency.

The servo circuit requires a reference voltage which determines the correct servo position. The reference voltages required for the servos are recorded on the Transmitter Band Chart for the different frequencies. The position voltage is feedback from a potentiometer mechanically connected to the servo mechanism. When the servo is activated, the servo will always try to make the position voltage from the feedback pot the same as the reference voltage.

NOTE

The SERVO REFERENCE PAL U22 is not used in this application.

R.5.16 Tune Servo Assembly

The Tune Servo motor B1 in the 2A6 Servo Drive Assembly is connected via a gear assembly to 3 variable capacitors, 2C1B through 2C1D. This group of three capacitors is connected across fixed capacitor 2C1A. As the servo is varied, the total capacitance changes, and the input bandpass filter is tuned to resonance.

R.5.17 Tune Servo Amplifier

The Tune Servo Amplifier U41 is a high power operational amplifier in a TO-3 case mounted on the heatsink underneath the board.

The +17/-15VDC supplies are connected to the supply pins.

This amplifier will compare the reference voltage at the (-) input with the servo position voltage at the (+) input. If there is a difference in the two voltages, the servo amp output at J14 will produce sufficient current of the proper polarity to drive the servo motor B1 to the correct location and make the position voltage the same as the reference.

The Tune Gain feedback potentiometer R81 is adjusted so that when the circuit is active, hunting or oscillations do not occur in the system.

Feedback resistors from the output limit the maximum drive current to 6.5A, and diodes from the output to the supplies clamps any voltage spikes for driving the inductive load.

R.5.18 Digital Reference Circuit

The function of the Digital Reference circuit is to develop the reference voltage for the servo amplifier. This voltage is varied in increments as a function of the particular frequency chosen.

A frequency shiftable digital up/down counter and digital potentiometer is used to provide coarse/fine adjustment of the reference voltage as needed during the different tuning modes.

R.5.19 Tune Reference Digital Potentiometer

The digital reference circuit consists of an 8 bit digital potentiometer U33, which will produce an output voltage of negative 0-14VDC depending on the 8 bit input.

The Tune Upper Limit pot R510 sets the maximum +14VDC input reference voltage possible, which corresponds to the upper mechanical stop of the assembly.

If all 8 DB0 through DB7 inputs are logic high, the output voltage at U33-1 will be +12.7VDC. When all inputs are logic low (except DB0 discussed later), the output will be 0VDC. The output reference voltage is inverted and connected to the Tune Reference Bypass Jumper JP3.

When JP3 is in the Normal position, the output is connected to inverter buffer. If in the Bypass position, the servo can be manually tuned with the Tune Bypass Reference Adjustment R91.

R.5.19.1 Inverter Buffer

The negative 0-14VDC input is inverted to a positive voltage by U31 and connected to the Servo Amplifier (-) input, the Tune Servo Fault Detector, and the Tune Reference Multimeter at J19.

The Tune Lower Limit pot R511 is adjusted so that when the input is 0VDC, the output is approximately +.7VDC. This corresponds to the lower mechanical stop of the assembly. (This voltage is 1.2VDC for the Load Servo).

R.5.20 REFERENCE COUNTER PAL

The REFERENCE COUNTER PAL is a 5 bit two frequency up/down counter that controls the digital pot that provides variations in the reference voltage. It also contains some of the logic for detecting a Tune Servo Fault.

Refer to Figure R-3 REFERENCE COUNTER PAL Encoder for the following example.

R.5.20.1 Up/Down Counter Clocks

When in the Frequency Change mode, the clock input from the SERVO PAL will be 12.5Hz and the active high Raise/Lower inputs will cause fast up/down binary counting of the 8 bit output and corresponding servo movement.

When in the Low or High Power Tune modes, the clock input from the SERVO PAL will be 3.1Hz and the active high Raise/Lower inputs will cause slower up/down binary counting of the 8 bit output and corresponding servo movement.

R.5.20.2 Counter Reset

The highest up count 8 bit output is all logic high. The lowest down count output is 00000001 from DB7 to DB0 respectively.

If the A/C power is lost and the battery backed-up +5VC is depleted, the Reset input will be logic low. When the power

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returns, the counter will reset to 00000000 respectively, and the servo will return to the lower limit. The output of the Digital Comparator will generate a Servo Fault that applies an RF Mute to the transmitter when manually turned on again. The Servo Fault in conjunction with the A/C Mains Fault will alert station personnel to go the Frequency Change mode to reset the reference voltage for the selected frequency.

R.5.20.3 Servo Fault

If the Tune Fault input from the detector or the Digital Comparator output is logic low, a Servo fault will be generated.

R.5.21 Load Servo Circuits

The Load Servo motor B1 in the 2A7 Servo Drive Assembly is connected via a gear assembly to variable inductor L2. As the servo is varied, the total inductance changes, and the output matching is tuned to the proper value.

The Load Servo circuits are the same as the Tune circuits.

R.5.22 SERVO PAL

The servo logic circuitry is responsible for turning on the servo circuits when a need to tune the transmitter occurs. To prevent the servos from operating full time, the logic detects when a request for servo action is required and powers the servo drive circuits long enough to allow the tuning to occur. The servo control circuits do not allow the reference to be changed unless the transmitter is in the proper Frequency Change mode.

Refer to Figure R-4 SERVO Encoder for the following example.

R.5.22.1 Clock Shifter

When the Frequency Change input is logic high, the Clock output will be 12.5Hz, and the active high Tune Raise/Lower and Load Raise/Lower are enabled.

When the Low Power Tune of High Power Tune input is logic high, the Clock output will be 3.1Hz, and the active high Tune Raise/Lower and Load Raise/Lower are enabled.

When in the Normal Mode, the reference voltage can not be changed.

R.5.22.2 Servo Supply Enable

When any of the raise/lower outputs is active high, the Timer Trigger output will be logic high. This will activate retriggerable one-shot timer U23. The Time Input on U18-13 will be logic high and if the Door Interlock is logic high, the Servo Enable will turn on the servo supplies.

When all raise/lower outputs go to a logic low, 60 seconds later the Servo Enable will go low and turn off the supplies.

Anytime an interlocked door is opened, the supplies will be shut off.

R.5.23 Servo Supply Regulators

Regulators are used for the servo driver amplifier supply voltage to allow steady state voltage to be available to the amplifier when required. One minute after the last servo raise/lower movement, the regulators are turned off.

R.5.23.1 +17/-15 Volt Servo Supplies

The + and - 20VDC supplies are connected to zener regulated pass transistors Q3 and Q5 that provide the respective voltages. An indicator will be illuminated GREEN when the supply is activated and the voltage may be measured at the test point.

R.5.23.2 Servo supplies Relay Enable

When K1 is de-energized, the base voltage is shorted to ground and the supplies are turned off. When Servo the Enable output from U18-14 is logic high, Q4 is turned on, K1 is energized, and the supplies are turned on.

R.5.24 Tune Servo Fault Detector

This circuitry will also compare the reference voltage with the position voltage and produce a fault output if the two voltages are not the same. This condition would occur if there was a problem with the servo circuit such that the servo motor could not produce the same position voltage as the reference. Examples

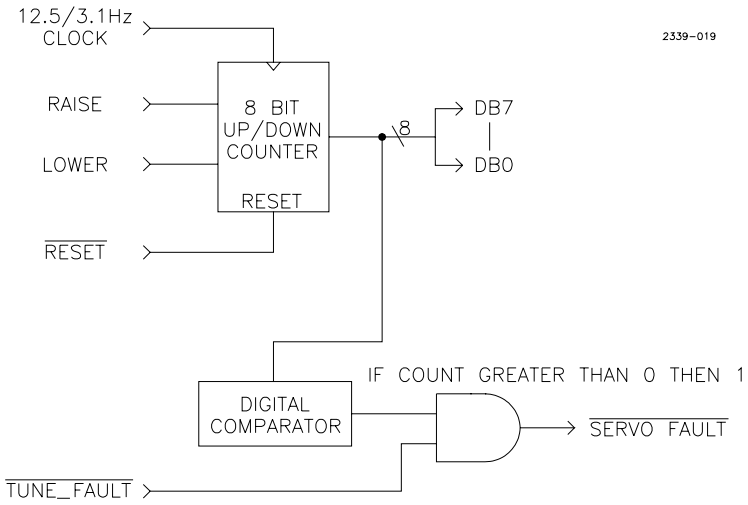

Figure R-3. Reference Counter PAL

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of servo faults would include mechanical problems with the servo or electrical problems with the motor, servo drive amp, or power supply. This fault would not allow the transmitter to put out power since the transmitter may not be at the proper tuning point.

R.5.25 Tune Servo Position Sample

Two voltages are taken from the Tune Servo Assembly and used in the servo control.

R.5.25.1 Tune Servo Position Feedback

A potentiometer is mechanically connected to the servo and provides the position voltage. A resistor is in series with the wiper that makes the output voltage non-linear, such that it tracks circuit Q.

R.5.25.2 Tune Servo Motor Current Feedback

A low value shunt resistor is connected from the motor to ground. The voltage across the shunt will be very small and change in polarity, depending upon the motor direction.

R.5.25.3 Tune Servo Low Pass Summing Amplifier

Both sample inputs are connected to a summing amplifier and buffer U44. The output Load Position voltage at TP43 is connected to the Servo Amplifier (+) input, the Tune Position Multimeter at J19, and to the Tune Servo Fault Detector.

R.5.25.4 Tune Servo Differential Amplifier

Both the reference and position voltages are applied to inputs of differential amplifier U44. If both inputs are equal, as they should be, the output voltage will 0VDC. A resistive level shifter at the output applies 7.5VDC to the window detector at TP48.

R.5.25.5 Tune Servo Window Detector

If the 2 voltages at the differential amplifier are not the same, the input voltage to U43 will increase or decrease. If the voltage at TP48 is greater than 8VDC or less than 7VDC, the comparator output will go logic low and generate a Tune Fault at TP45. This output is connected to the Tune REFERENCE COUNTER PAL which will generate a Tune Servo Fault.

R.5.26 Load Servo Fault Detector

The Load Servo Fault Detector is the same as the Tune.

R.5.27 Efficiency Coil Board Interlocks

The Bit 0 and Bit 1 information loops through the interconnections for the 8 Efficiency Coil boards inside the respective

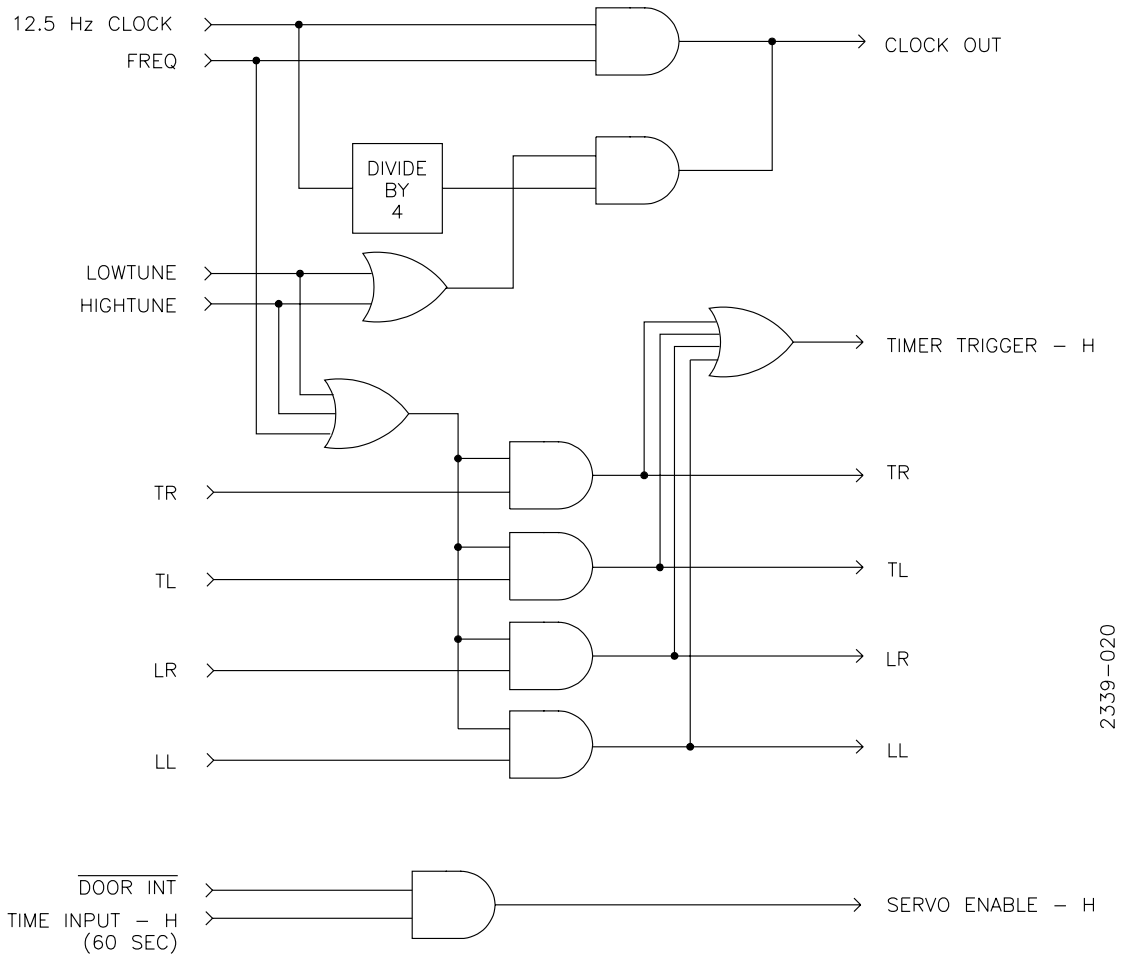

Figure R-4. Servo Encoder

WARNING: Disconnect primary power prior to servicing.

compartments. If a cable is disconnected, the relays on the board might not be in the correct position.

NOTE

The Driver Section has only 2 Efficiency Coil boards.

R.5.27.1 Closed Loop

A single +24VDC supply leaves the Frequency Control Interface board and loops through all connections, and eventually returns back to the input of a comparator. If all connections are made, the voltage at the (+) input will be greater than the (-) inputs. The output is logic high, which is the normal condition.

R.5.27.2 Open Loop

If any of the connections are open, the output of the comparator will go logic low. This will generate a logic low Bandswitch Fault via U16 and illuminate appropriate indicator of DS10 RED. An RF MUTE will be applied to the transmitter and the front panel Bandswitch Fault LED will be illuminated RED on the Frequency Control Panel.

R.5.28 Band Fault Detectors

The same basic circuit is duplicated for the Predriver connector J1, Driver connector J2, 2L1/2C2 connector J7, and 2C3/2C4 connector J10. When any one is disconnected, the appropriate indicator of DS10 and the Bandswitch Fault indicators will be illuminated RED.

R.5.29 VSWR PAL

The VSWR PAL receives the Band Data and encodes the active high outputs for the Antenna and Network VSWR Detectors on the Output Monitor at J15. For the Antenna VSWR output, the PAL uses the External Adjustment BCD input and converts it to a binary output. Each output is a 5 bit system.

R.5.30 RF Samples Interface

The Synthesizer Sync, Buffer, Predriver, and Driver voltage samples are connected to Multimeter Selector Switch on the Frequency Control board at J20.

R.5.31 Bandswitch Indicators

DS11 may be used to check the output levels of the relay drivers. To use, simply connect the five conductor cable from J51 to any of the J52 through J56 connectors. If the output is 0VDC, meaning the relay should be energized, the indicator will be illuminated RED.

NOTE

Depending upon the particular connector, the indicators may monitor different bit outputs.

R.5.32 Power Distribution

R.5.32.1 +24VDC

The +24VDC supply input is fused by F1 through F7 and connected to the all of the relays and interlock circuits.

R.5.32.2 +15VDC

The +15VDC supply is connected to the Tune Load raise/lower control switches on the Frequency Control board at J13.

R.6 Troubleshooting

Circuitry on this board can be classified into these major areas:

a. Power Supply
b. Bandswitching
c. Tune Mode Control
d. Faults
e. Servo Control

R.6.1 Power Supply

When a Power Supply fault is displayed on the Frequency control front panel, then with only the low voltage on, check the LED indicators on the board:

a. DS5 (+5V)
b. DS4 (-15V)
c. DS6 (+15V)

Each of these LED indicators should be illuminated, if the individual supplies are operating normally.

a. If DS3 is illuminated RED:
b. Use a multimeter to measure the +15VDC, +5VDC, and -15VDC power supplies.
c. If any supply has been reduced to less than 80% of normal:
   1. Check the input fuse and replace if necessary.
   2. If fuse is not open, measure input TP for the unregulated voltage.
   3. If the unregulated input is correct, replace the regulator.
d. If all supplies measure correct:
   1. Check TP29 for +5VDC and replace U38 if necessary.
   2. If TP29 is okay, measure the voltages on the comparator inputs and outputs to determine if the comparator is faulty.

R.6.2 Bandswitching

NOTE

If a failure has occurred in a bandswitching circuit, it is possible to bypass the problem. Refer to the Emergency Operating Procedures for more information.

R.6.2.1 Band Latch

a. Check the inputs/outputs of the Band Latch when switching from Low Power Tune to the Frequency Change mode.
b. Verify the 100ms output pulse.
   1. If not correct, check the Band Latch clock input, verify U15-5 is logic high and has the 12.5Hz clock input.
   2. If not correct, replace Band Latch, U15, or U21 if needed.

R.6.2.2 Encoder PALs

a. Check the Encoder outputs at a given frequency.
b. Use the Encoding Examples to determine the logic levels out of the PAL.
   1. Check the PAL inputs.
   2. Use the Band Indicator jumper to check the output status of the PAL
   3. Replace the PAL if needed.

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R.6.2.3 Relay Drivers

a. If the PAL output is correct, but the relay(s) does/do not switch.

b. Remove the input jumper plug for the driver.

1. Connect the input to ground, the driver output should be 0VDC at the output connector.
2. Connect the input to +5VDC, the driver output should be +24VDC low at the output connector.
3. If incorrect measure the +24VDC supply, and ohmmeter test the relay coil at the connector, or replace the driver if needed.

R.6.3 Tune Mode Control

R.6.3.1 Mode Switching

a. Check for active high inputs to the PAL from the Mode Select Switch.

b. Check for 12.5Hz clock input at PAL.

c. Check for the active high out pulse high in Low Power Tune and High Power Tune.

1. If inputs are corrects, but PAL outputs are not, replace the PAL.
2. If the PAL outputs are correct, check the inverter levels and replace if needed.

R.6.4 Fault Outputs

R.6.4.1 Efficiency Coil/Bandswitch Faults

a. Measure the comparator (+) input, which should be greater than the (-) input. The comparator output should be logic high.

1. If the inputs are correct but the output is not, replace the comparator.

b. If all comparator outputs are logic high but the fault input to the PAL is logic low, replace the NAND gate.

c. If both fault inputs to the PAL are logic high, replace the PAL.

R.6.4.2 Servo Faults

a. Measure the Reference voltage and the Position voltage at the input test points of the differential amplifier, and the fault output test point at the window comparator.

b. If the voltages are not the same, skip to servo comparison troubleshooting.

c. If the voltages are the same, measure the 7.5VDC test point.

1. If not 7.5VDC, replace the differential amplifier.
2. If 7.5VDC and the fault output test point is logic low, measure the window voltages and replace the comparator if needed.

d. If the fault output test point is logic high and the REFERENCE COUNTER PAL has not been reset, replace the PAL.

R.6.5 Servo Control

R.6.5.1 Servos Do Not Turn On

a. If both servos do not turn on, check for active high raise/lower inputs to the SERVO PAL.

1. If not present, check the inputs at J19 and the Frequency Control front panel switches.
2. Check the Door Interlock input.

b. Measure the Timer Trigger output and 60 second Timer input to the PAL.

1. If raise/lower inputs go high and the Timer Trigger does not, replace the PAL.
2. If the 60 second Timer input is not high for 60 seconds, replace U23.

c. Check the servo relay enable PAL output at U18-14. If high, K1 should energize and the green DS1 and DS2 should illuminate.

1. If no enable is present, replace the PAL.
2. If the enable is high, check Q4 and K1.
3. If K1 energizes, measure the regulated and unregulated voltages, check the pass transistors & the zener voltages.

R.6.5.2 Servos Do Not Change

a. Measure the clock input and output of the PAL. The output should be 12.5Hz when the Frequency Change input is high, and should be 3.1Hz when the Low or High Power Tune inputs are high.

1. If no 12.5Hz clock input, replace U21.
2. If no or incorrect clock output, replace the PAL.
3. If no active high mode inputs check the input at J19 and the Frequency Control board.

b. Measure the active high tune and load raise/lower outputs.

1. If the inputs go high but the outputs do not, replace the PAL.

NOTE

If a failure has occurred in the reference circuit, it is possible to bypass the problem. Refer to the Emergency Operating Procedures for more information.

R.6.5.3 Servo Comparison

a. If one servo is active and can be changed, use this operational circuit as a reference for comparing the voltages on both circuits.

R.7 Removal\Replacement

With the low voltage power supplies shut off, remove all connectors and top outside mounting screws.

When installing the replacement board, reverse the above procedure. Ensure that all jumpers and switches are set to the same position as the original board.

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R.8 Alignment

The same procedure may be used for both the Tune and Load Servos

R.8.1 Lower Electrical Stop

a. Monitor the Position voltage for the servo.
b. Lower servo until meter stops decreasing, and note the number.
c. Shut off the Servo Breaker.
d. Monitor the Reference voltage and hold down the Lower switch until the counter stops.
e. Adjust the Lower Limit pot until the meter reads the same as the voltage noted earlier plus 0.1 Volts.

R.8.2 Upper Electrical Stop

a. Monitor the Position voltage for the servo.
b. Raise servo until meter stops increasing, and note the number.
c. Shut off the Servo Breaker.
d. Monitor the Reference voltage and hold up the Raise switch until the counter stops.
e. Adjust the Upper Limit pot until the meter reads the same as the voltage noted earlier minus 0.1 Volts.

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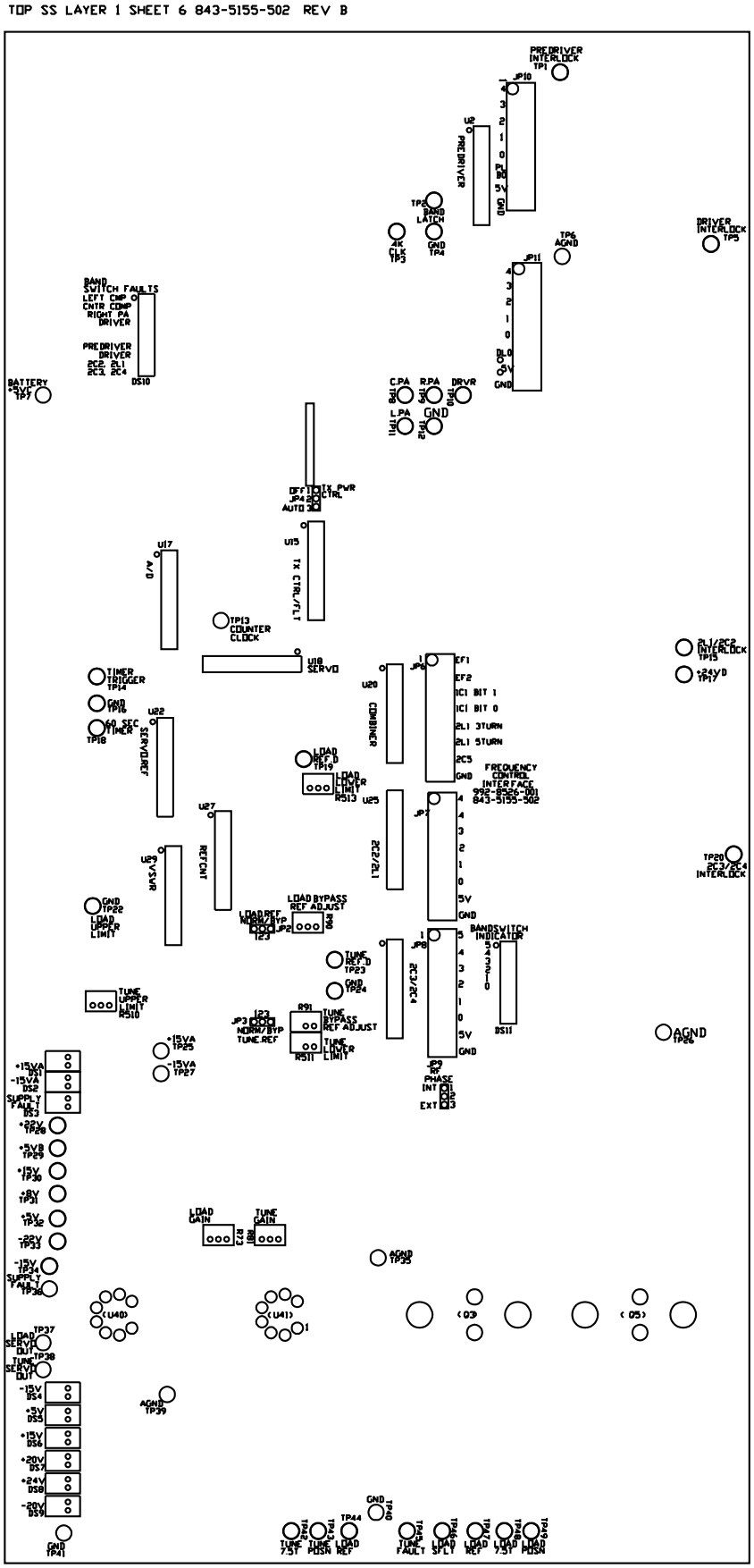

Figure R-5. Frequency Control Interface Controls and Indicators

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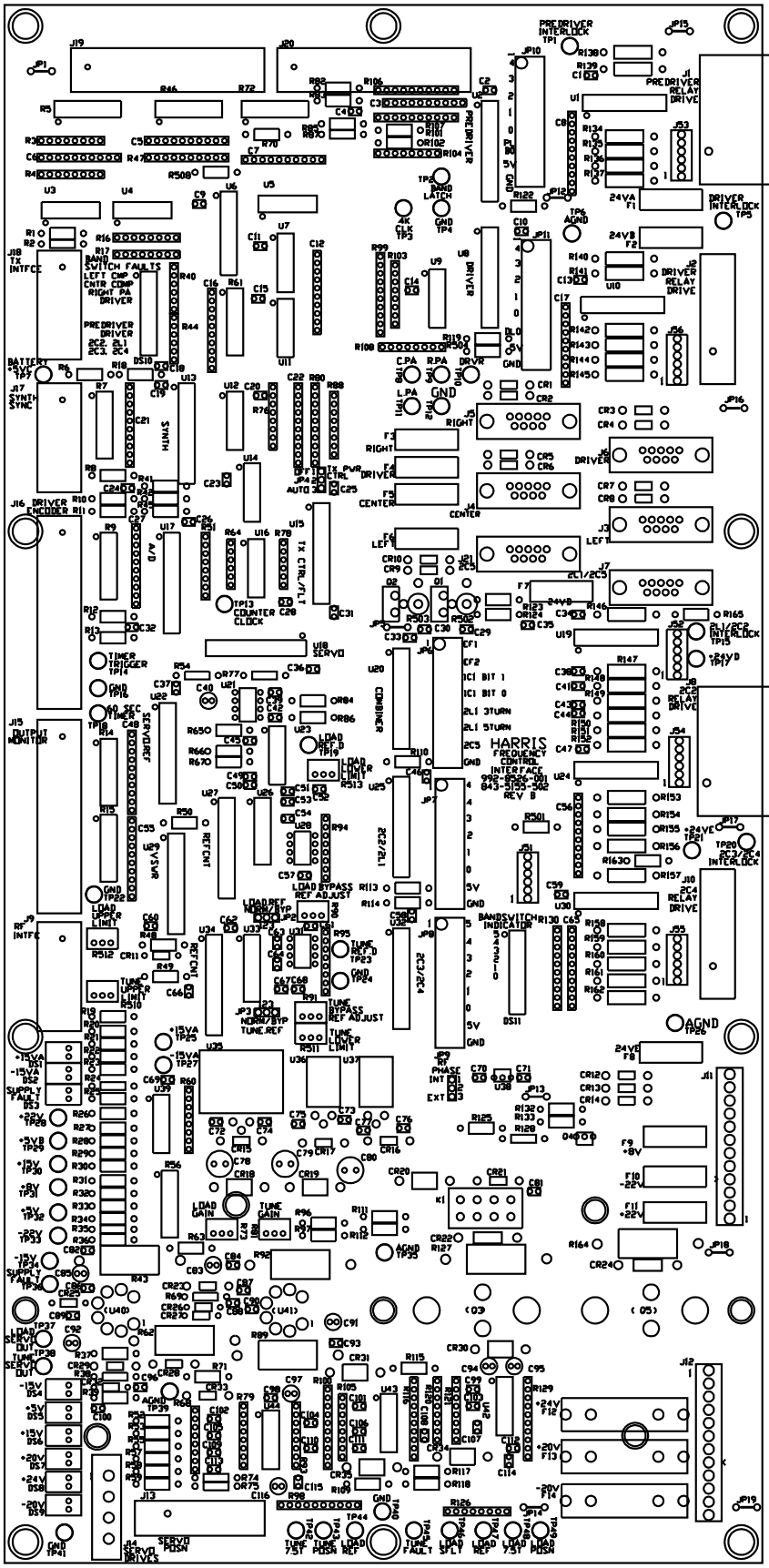

Figure R-6. Frequency Control Interface Component Location

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WARNING: Disconnect primary power prior to servicing.

S.1 Introduction

This section describes the 3Frequency select Board. Topics include Function and Location.

Parts list for this board is in Section VII.

Board # 843 5523 973
Schematic # 843 5523 971
PWA # 992 9764 500

S.2 Function

The 3F select board is used to select 1 of 3 predetermined frequencies. By selecting 1 of the 3 Frequency Pushbuttons a command will then be issued to the 3F controller (described later). Also on this board is the current status of the Transmitters Frequency. LED's imbedded in the switches tell you what the current Freq is by 3 latching relays. In the event of an AC failure and when AC is restored the last state that the Relays were in will represent the current state.

S.3 Location

The 3F select board is located on the Left PAC front Door. Next to the Frequency Control Board. See View 24.

Refer to Schematic # 843 5523 973 for the following discussion.

Frequency 1 Selection. Switch # 1 is a momentary pushbutton switch. When activated a Gnd is sent to the 3F controller. The controller will send a Set command to K1 and a Reset command to K2 and K3.

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T.1 Introduction

This section describes the 3 Frequency Controller Board. Topics include Function, Location, and troubleshooting.

Board # 843 5400 733
Schematic # 843 5515 842
PWA # 992 9511 588

T.2 Function

The 3F Control Board is used to send 1 of 3 frequencies to the synthesizer module. Depending on the 3 inputs lines that come from the 3F select board will determine the Frequency.

When a Frequency is selected on the 3F Select board the 3F Controller will issue a frequency change command to the freq control board. The transmitter will shut off and the transmitter will change to the frequency selected.

The frequency change will be removed once both servos have reached the reference within 0.060 Volts or the NORM/CALIBRATE switch (S100) is in the CALIBRATE position.

NOTE:
When S100 (NORM/CALIBRATE) is in the CALIBRATE position neither the FREQUENCY CHANGE or the NORMAL LED on the front panel will be illuminated.

The 3F controller will issue an F1, F2 or F3 command to the freq Controller this will determine the Ant and Net VSWR settings

The 3F controller will issue the correct binary value for the freq selected to freq controller, which will decode that value and select the appropriate settings throughout the transmitter.

T.3 SERVO CONTROL

The servos will travel to a predetermined position control by the variable potentiometer. See chart below.

Freq	U31 pin	Tune REF	U31 pin	Load REF
1	6	R44 & R57	10	R26 & R50
2	7	R48 & R52	11	R46 & R55
3	8	R27 & R56	12	R25 & R54

U31 pin	Tune POS	U31 pin	Load POS
5	R47 & R51	13	R45 & R49

Depending on the distance the servo has to travel in order to reach its reference will determine the speed of the servo.

If the Difference between the Tune Ref Voltage and Tune Pos Voltage is greater than 2.45V than the 3F controller will Active the Tune Raise/Lower.

If the Difference between the Tune Ref Voltage and Tune Pos Voltage is less than 2.45V and greater than 1.22 volts than the 3F controller will pulse the Tune Raise/Lower .every 0.125 seconds.

If the Difference between the Tune Ref Voltage and Tune Pos Voltage is less than 1.22V and greater than 0.060 volts than the 3F controller will pulse the Tune Raise/Lower .every 0.5 seconds.

If the Tune Ref Pos is Greater than the Tune Ref Voltage then the Tune Lower will be activated.

If the Tune Ref Pos is less than the Tune Ref Voltage then the Tune Raise will be activated.

The Tune Raise/Lower command stops once the Difference between the Tune Ref Voltage and Tune Pos Voltage is less than 0.060 volts

Once the servos have reached that position the 3F controller will issue a Normal command to the Freq Controller.

You are then able to select Low, Med, or High power level.

NOTE:
If the servos do not reach the position required then the 3F Controller will not issue a Normal Command. An RF Mute will be generated until the difference between the Ref & Pos voltages is less than 0.3 Volts.

T.4 Location

The 3F Controller board is located on the Left PAC front Door. Above the Frequency Control Board. See View 24

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U.1 Servo Calibration

When S100 is in the Calibrate Position Adjust the Tune and Load servos for a Power Peak and the amount of current for the # of Modules ON.

When this is achieved, Adjust the following:

TUNE SECTION				
POTS	MEASURE		MEASURE	FREQUENCY
R44,R57	U31 PIN 6	=	U31 PIN 5	FREQ 1
R48,R52	U31 PIN 7	=	U31 PIN 5	FREQ 2
R27,R56	U31 PIN 8	=	U31 PIN 5	FREQ 3

LOAD SECTION				
POTS	MEASURE		MEASURE	FREQUENCY
R26,R50	U31 PIN 10	=	U31 PIN 13	FREQ 1
R46,R55	U31 PIN 11	=	U31 PIN 13	FREQ 2
R25,R54	U31 PIN 12	=	U31 PIN 13	FREQ 3

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Appendix A
DX Digital Modulation Technology and Concepts

a.1 DX Digital Modulation Technology and Concepts

a.1.1 Digital Terms and Concepts

The discussion of Analog to Digital and Digital to Analog Conversion will include some terms, abbreviations, and concepts used in this Technical Manual which may not be familiar to some Broadcast Station engineers and technicians. A summary is included here for review or reference.

a. ANALOG refers to something that has a continuous range of values, rather than changing in steps. Examples of analog signals are the audio signals from a microphone, a turntable cartridge, or a normal tape playback head.

b. DIGITAL is related to digits, or discrete quantities. An analog signal changes continuously, but a digital signal changes in steps. An analog signal has an infinite number of possible values, and a digital signal has a finite, or limited, number of possible values.

c. BINARY: Has only two possible values. A BINARY NUMBER is a number represented using only the digits 0 and 1. This is useful in electronic circuitry because a circuit can be ON or OFF (two states). A logic signal may be one of two different Voltages, referred to as HIGH (binary 1) or LOW (binary 0) in this Technical Manual.

d. BINARY can also refer to a series where each step is either multiplied or divided by two to get the next step. An example, in the transmitter, is the Binary RF combiner steps, which are 1/2 step, 1/4 step, 1/8 step, and 1/16 step. In this series, each step is divided by two to get the next step.

e. BIT: A Binary digit, 0 or 1.

f. DIGITAL WORD: A DIGITAL WORD is a series of numbers, or a group of bits, representing a complete piece of digital information. The term “DIGITAL WORD”, when used here, will always refer to a binary number, which is a series of ones and zeros. The number of BITS in a DIGITAL WORD is the total number of digits (ones and zeros). Examples of a six bit digital word are “010010“ and “110101.” A 12 bit digital word is “0100 1000 1101.”

g. MSB: Abbreviation for MOST SIGNIFICANT BIT. In a digital word, as in a decimal number, the first digit represents the largest change, and is the MSB.

h. LSB: Abbreviation for LEAST SIGNIFICANT BIT. In a digital word, as in a decimal number, the last digit represents the smallest change, and is the LSB.

i. BIT 1, BIT 2, etc.: In a 12-bit digital word, the bits are numbered from 1 through 12, where Bit 1 is the MSB, and Bit 12 is the LSB.

j. A/D: Also written “A to D.” Abbreviation for “Analog to Digital.”

k. D/A: Also written “D to A.” Abbreviation for “Digital to Analog.”

l. ADC: Abbreviation for “Analog to Digital Converter.

m. DAC: Abbreviation for “Digital to Analog Converter.

Some Basic Digital Circuit Concepts, which will be used in the following discussion and in circuit descriptions, are also included for review or reference.

In logic circuits, representing a digit by either zero or one is useful because it can be represented by a switch or a circuit that is either “off” or “on.” The digits “zero” and “one” may also be represented by a Voltage that is LOW for “zero” and HIGH for “one.”

In circuit descriptions and on schematic diagrams, the terms “logic LOW” and “logic HIGH” are used. These terms may also be represented by the letters “L” and “H,” particularly on schematic diagrams. In most of the digital logic circuits, normal TTL (transistor-transistor logic) levels are used, and a “logic LOW” is represented by a Voltage near zero (between approximately zero and one Volt), and a “logic HIGH” is represented by a Voltage near +5 Volts (between approximately +3.5 and +5 Volts). On block diagrams and on schematic diagrams in this Technical Manual, when a signal description is followed by “-L” or “-H,” the letter indicates the logic state when the signal is ACTIVE. Examples: “RESET-L” indicates that when the signal is logic LOW, a RESET will occur, or a RESET command is being given. “VSWR-H” indicates that when the signal is logic HIGH, a VSWR fault has occurred.

A DIGITAL WORD can represent only a finite number of quantities or steps, depending on the number of bits in the digital word.

If n = the number of bits in the digital word, then:

2^n = the number of quantities that may be represented by that word.

If a digital word has 12 bits, it may represent 2^{12}=4096 quantities.

“VALUE” OF EACH BIT: The least significant bit (LSB) represents one unit. The next least significant bit represents two units. The most significant bit represents 2^{n-1} units. Example: In a 5 bit digital word":

Bit 1 (MSB) represents 16 units

Bit 2 represents 8 units

Bit 3 represents 4 units

Bit 4 represents 2 units

Bit 5 (LSB) represents 1 unit.

The basic principles of this new modulation technique are not difficult to understand, especially if we first review some basic principles of amplitude modulation and digital electronics technology. A basic discussion is included in the following paragraphs, as an introduction or review for technical personnel who

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are not familiar with A/D and D/A conversion techniques. This discussion will provide a background for a discussion of these sections of the transmitter.

a.1.2 Analog to Digital Conversion Process

Before continuing with a description of transmitter circuits, the Analog to Digital (A/D) and Digital to Analog (D/A) conversion processes will be reviewed. This review will provide a background for discussing the transmitter's modulation section.

The Analog to Digital (A/D) conversion process takes place in three steps:

a. Divide the time scale into equal intervals.
   1. At each time interval, the amplitude (voltage) of the analog signal is sampled and recorded.
   2. For each recorded sample, a digital word is constructed that represents the analog sample.

In the following explanation of these steps, the numbers used do not represent Voltages used in the transmitter, but are used only as an example.

STEP 1:

Divide the time scale into equal intervals.

The analog input signal is a signal which changes with time. (In the transmitter, this is an audio signal). Each interval or division will be a "sample interval."

STEP 2:

Sample and record the analog signal.

The analog to digital converter takes a finite amount of time to convert the analog signal into a digital word. The input to the analog to digital converter should not change during the time that the conversion is taking place. It is necessary to sample the Voltage, then store or record it during the conversion. The signal is sampled at the beginning of the time interval.

STEP 3:

For each sample point, construct a digital word that best approximates the analog sample.

A digital word is represented by a series of zeros and ones. Each digit in the digital word is called a "BIT." Each digital word represents a range of analog Voltages.

If a five-bit digital word is used, there are 32 possible words, from "00000" to "11111." The total analog Voltage range, then, is divided into 32 equal Voltage ranges and each digital word represents one of these Voltage ranges. Table 4-1 shows some Voltage ranges and five-bit digital words for a 0.00 to +8.00 Volt signal. Each digital word represents a range of Voltages of (8.00/32=0.25) Volt.

For each time interval in Step 1 (for each "sample interval"), the digital word corresponds to the Voltage at the beginning of the time interval, because the analog signal is sampled at the beginning of each time interval. Note that the analog signal amplitude has INFINITE precision (many decimal places), but the digital word has a finite word length, and each digital word length represents a range of Voltages. This results in a round off or quantization error. For the 5 bit digital word in the example, the round off error could be as large as 0.25 Volts.

If a longer digital word had been used (more bits in the digital word), the round off or quantization error would be smaller. For example, if the digital word length were 8 bits, it could have any of 256 values (from 0000 0000 through 1111 1111). For an analog signal varying from 0.000 Volts through +8.000 Volts, "0000 0000" would now represent Voltages from 0.000 through +0.03125 Volts; "1000 0000" would represent Voltages from 4.000 through 4.03125 Volts, and so on. By increasing the digital word length from 5 bits to 8 bits, the maximum round off or quantization error would be reduced from 0.25 Volts to 0.03125 Volts.

A 12 bit digital word could have any of 4096 values, from 0000\0000\0000 through 1111\1111\1111, and would have a still smaller quantization error. As the quantization or round off error becomes smaller, the series of digital words represents the analog signal more closely.

A key point in Analog to Digital Conversion, then, is:

THE MORE BITS THERE ARE IN THE DIGITAL WORD, THE MORE ACCURATE THE REPRESENTATION OF THE ANALOG SIGNAL WILL BE.

The RESOLUTION may be expressed as the number of bits in the digital word. If "n" is the number of bits, the number of steps represented by a digital word is (2^n-1) when the "zero" step is not counted. For a 5 bit word, $2^5-1 = 31$ steps; for an 8 bit word, $2^8-1 = 255$ steps; and for a 12 bit word $2^{12}-1 = 4095$ steps.

Sample Time Interval

The sample time interval used must be short enough so that each significant change in the analog signal is represented by a new digital word. The sample frequency must be at least two times the highest frequency for proper recovery of the analog signal. Higher sample frequencies will reproduce the analog signal more accurately. (The sample time interval, "t" is the inverse of the highest sample frequency "f" so that t=1/f.)

The sampling time interval must also be long enough to allow the analog to digital conversion process to take place. The high speed A/D converter used in the transmitter requires about 0.9 microseconds (900 nanoseconds) for a conversion.

In the transmitter, a 12 bit analog to digital converter (ADC or A/D converter) is used for high resolution. The effective resolution of the digital to analog conversion (DAC or D/A conversion) process in the transmitter's RF power amplifier stage is about 11.4 bits, or about 2,800 steps ($2^{11.4}$ is approximately 2800). RF power amplifier resolution is less than 12 bits because a linear D/A converter is not used; this will be explained later. The sample frequency is between 400 kHz and 820 kHz, depending on the transmitter carrier frequency.

a.1.3 Digital To Analog Conversion

The digital to analog conversion process (D/A conversion) is simply the reverse of the analog to digital (A/D) process, and takes place in two steps:

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1. Re-create the analog Voltage represented by the digital word by turning on or off units of dc Voltage (or RF Voltage) and holding it constant for one time interval.
2. Pass the reconstructed audio through a low pass filter to remove the steps. This low pass filter may also be called a reconstruction filter. It acts as a "smoothing filter," removing the steps to provide a high quality analog signal.

STEP 1:

Re-create the analog Voltage represented by the digital word. Each bit of the digital word represents some amount of Voltage. For a five bit digital word and an analog Voltage range of zero to eight Volts (used in Table 1), each bit represents a Voltage as follows:

Bit 1, 4.00 Volt (MSB)

Bit 2, 2.00 Volt

Bit 3, 1.00 Volt

Bit 4, 0.50 Volt

Bit 5, 0.25 Volt (LSB)

Note that the Most Significant Bit (MSB) represents one-half of the maximum analog Voltage, and each additional bit represents one-half of the Voltage of the bit before it.

The analog Voltage can be reconstructed by providing a Voltage source, either dc or RF, for each of the Voltages represented by bits in the digital word, then using these Voltages as inputs to a summing circuit with a switch to turn each Voltage OFF if the bit is zero or ON if the bit is one. An example from Table 7-1 will be used to illustrate this process. When the input to the A/D converter is +3.914 Volts, the digital word constructed is 01111. The D/A converter, then, sums (2.00 + 1.00 + 0.50 + 0.25) for a total of 3.75 Volts. If the digital word is 00101, the output of the D/A converter is (1.00 + 0.25) = 1.25 Volts.

The least significant bit in the digital word represents 0.25 Volts in this example, so that the output of the D/A converter must change in 0.25 Volt steps. Note that this is the same as the 0.25 Volt quantization error in the example of the Analog to Digital conversion used in the previous section. The analog input Voltage to the Analog to Digital converter changes in continuous manner, but the output of the Digital to Analog converter changes in steps. The re-created Voltage at the output of the D/A converter is an approximation of the original analog input Voltage. The maximum round off or quantization error in the re-created analog Voltage is the size of the steps. As the number of bits in the digital word increases, the Voltage step represented by the least significant bit becomes smaller, the steps in the re-created analog Voltage from the D/A converter become smaller, and the re-created Voltage more closely approximates the original analog Voltage.

STEP 2:

Pass the reconstructed audio through a low pass filter to remove the steps. Because the low pass filter smoothes the steps, it may be called a "smoothing filter"; it is also called a "reconstruction filter" because it reconstructs a better approximation of the original audio signal from the stepped output of the D/A converter.

Sharp "corners," steps, or transitions in a waveform are caused by high frequency harmonics in the signal. The low pass filter attenuates or removes these harmonic frequencies, and therefore also smoothes or removes the sharp corners or steps in the waveform.

The Digital to Analog converter output can be any desired Voltage, limited only by the switching circuits in the converter. For example, the bits in the digital word could be used to switch Voltages of 100, 50, 25, 12.5, and 6.25 Volts, so that the digital word 00101 would produce a D/A converter output of (25 + 6.25) = 31.25 Volts, instead of (1.00 + 0.25) = 1.25 Volts as in the example. The bits in the digital word can also be used to switch Radio Frequency signal Voltages on and off to produce a varying or amplitude modulated RF signal.

Digital amplitude modulation simply takes the digital words and turns on and off units of RF Voltage instead of DC Voltage to create amplitude modulation. Then the transmitter output bandpass filter removes the steps to provide a high quality analog amplitude modulated signal.

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